The third migration into Neogæa established its links with Australia, bringing in Marsupials, both polyprotodont and diprotodonts. The fourth was from the north, Arctogæa, and is positively known ; it occurred at the end of the Miocene, and brought in the northern Carnivora, Bears, Wolves, Cats, and Sabre-tooth Tigers, Raccoons and Mustelines, the Artiodactyla, deer and camels, the Perissodactyla, horses and tapirs, three types of Rodents, the Squirrels, Mice and Hares or Rabbits and the Mastodon. The Notogæic types, as well as the animals of the first invasion, in the meantime had largely died out, and the introduction of more vigorous Arctogæic types, especially the carnivores, together with a change of climate, exterminated a further portion of the autochthonous Neogæic fauna. At the same time, that is of this second invasion, many of the South American forms entered North America; they seem to have reached this continent in the upper Pliocene.

We now turn to Arctogæa. In the Eocene period we find in Europe and North America what may be considered the pure or Autochthonous fauna of the Holarctic region, in the absence of all knowledge of Asia. Southern Asia is an absolute *terra incognita* the earliest known deposits in this region being in the Upper Oligocene in which the fauna is remarkably similar to that of Europe. Northern Asia is unknown paleontologically until the Pleistocene—here is a region for explorers. However, we may consider it as part of a broad Eurasiatic land area—extending from the Rocky Mountain Region to Great Britain. The faunal relations are astonishingly close, between the new and old worlds at this time. Every year's discovery increases the resemblance and diminishes the differences between Europe and the Rocky Mountain region. Distinguishing North America, however, are the Tylopoda, this sub-order includes the peculiar Artiodactyla of the Camel-llama tribe ; these Professor Scott in a recent paper considers as including all the early types of American ruminants which we have been vainly endeavoring to compare with European types. The radiation of the Tylopod phylum into a great variety of types is quite conceivable and it is thoroughly consistent with the fundamental law of adaptive radiation which we find operating over and over again.

In Europe there are in the upper Eocene two classes of animals, first those which have their ancestors in the older rocks. The second class includes certain highly specialized animals which have no ancestors in the older rocks—among these, perhaps, are the peculiar flying rodents or *Anomaluridæ*, now confined to Africa, and secondly the highly specialized even-toed ruminant types—the Anoplotheres, Xiphodonts and others, the discovery of which in the *Gypse* near Paris—Cuvier has made famous. It is tempting to imagine that these animals did not evolve in Europe but that they represent what may be called the first invasion of Europe by African types from the Ethiopian region.

It is a curious fact that the African continent as a great theater of adaptive radiation of Mammalia has not been sufficiently considered. It is true that it is the dark continent of paleontology for it has practically no fossil mammal history but it by no means follows that the Mammalia did not enjoy an extensive evolution there.

Although it is quite probable that this idea has been advanced before—most writers speak mainly or exclusively of *the invasion of Africa by European types.* Blanford and Allen it is true have especially dwelt upon the likeness of the Oriental and Ethiopian fauna but not in connection with its antecedent cause. This cause I believe to have been mainly an invasion from south to north correlated with the northern ex-

tension of Ethiopian climate and flora during the Middle Tertiary. It is in a less measure due to a migration from north to south. Let us therefore clearly set forth the hypothesis of *the Ethiopian region, or South Africa, as a great center of independent evolution* and as the source of successive northward migrations of animals, some of which ultimately reached even the extremity of South America—I refer to the Mastodons. This hypothesis is clearly implied if not stated by Blanford in 1876 in his paper upon the African element in the fauna of India.

The first of these migrations we may suppose brought in certain highly specialized ruminants of the upper Eocene, the Anomalures or peculiar flying rodents of Africa; with this invasion may have come the Pangolins and Aard varks, and possibly certain Armadillos, *Dasypodidæ*, if M. Filhol's identification of *Necrodasypus* is correct. A second invasion of great distinctness may be that which marks the beginning of the Miocene when the Mastodons and Dinotheres first appear in Europe, also the earliest of the Antelopes. A third invasion may be represented in the base of the Pliocene by the increasing number of Antelopes, the great giraffes of the Ægean plateau, and in the upper Pliocene by the Hippopotami. With these forms came the rhinoceroses with no incisor or cutting teeth, similar to the smaller African Rhinoceros, *R. bicormis*. Another recently discovered African immigrant upon the Island of Samos in the Ægean plateau is *Pliohyrax* or *Leptodon*, a very large member of the Hyracoidea, probably aquatic in its habits, indicating that this order (popularly known as the conies) enjoyed an extensive adaptive radiation in Tertiary times.

It thus appears that the Proboscidia, Hyracoidea, certain edentata, the Antelopes, the Giraffes, the Hippopotami, the most specialized ruminants and among the rodents, the Anomalures, the Dormice, the Jerboas and among Monkeys the Baboons may have enjoyed their original adaptive radiation in Africa—that they survived after the glacial period, only in the Oriental or Indo-Malayan region, and that this accounts for the marked community of fauna between this region and the Ethiopian as observed by Blanford and Allen.

Against the prevalent theory of Oriental origin of these animals is: first, the fact observed by Blanford and Lydekker in the Bugti Beds (Sind) that the Oligocene or lower Miocene fauna of the Orient is markedly European in type; second, that if these animals had originated in Asia some of them would have found their way to North America; third, the fact that all these animals appear suddenly and without any known ancestors in older geological formations. These are the main facts in favor of the Ethiopian migration hypothesis.

In the meantime the unification of the North American and Eurasiatic regions was proceeding by intermigration. In the lower Oligocene the giant pigs or elotheres, the Tapirs and peculiar amphibious rhinoceroses, known as Amynodons, found their way from America to Europe, while Europe supplied us with a few Anthracotheres, both Anthracotherium and Hyopotamus. In the Miocene Europe sent us the true Cats and we supplied Europe with the destructive sabre tooth tigers; in the upper Miocene Europe sent us our first deer and cattle or *Cervidæ* and *Bovidæ*, also probably the Mastodons *en route* from Africa. In the Pliocene we supplied Europe with the rabbits and hares, and possibly with the raccoons, if the Panda belongs to this family. In the Pleistocene the Camels wandered into Asia from America, while the Bears passed them *en route* to America. These are a few instances out of many which are already well known.

On the other hand certain families had an

exclusively Eurasiatic history, so far as we know. These are, among animals related to the horse and tapir, the Palæotheres and Lophiodon ; among ruminants the Traguline deer and Muntjacs ; among insectivores the hedgehogs ; among primates, the Anthropoid Apes and the lemurs. The latter are peculiar to the Malagasy and Ethiopian regions. At the same time America exclusively raised the Titanotheres,* the *Hyracodontidæ* or cursorial rhinoceroses, the pouched rodents or *Geomyidæ*, all the early families of Tylopoda, the peccaries. It is paradoxical that so many animals which we are wont to consider typically American came from the Eurasiatic region, while so many others which we always associate with Asia and Africa came from this country. Herein lies the necessity of a paleontological basis for zoogeography.

PLEISTOCENE DIVISIONS IN EUROPE.

The Pleistocene Quaternary or Glacial Age is the period in which the present distribution of animals and plants was determined. In this period the fulness of European investigation is in strongest contrast with the indecisive results of American work and in no other period can we anticipate more weighty inductions from Holarctic correlation. It is especially important to determine the relative antiquity of the first recorded traces of man in the two continents.

It is true the Pleistocene history of Europe is still in a formative stage, but it is absolutely evident that a final and positive time scale and subdivision of the early Age of Man is not far distant and that the vast labors of geologists, botanists, zoologists, paleontologists and anthropologists will be rewarded with a harmonious theory of all its phenomena.

Combined attack by geological and biological methods has nowhere produced more brilliant results. The unaided testimony of the rocks and soils fails to tell us of the successive advances and retreats of the ice but where, owing to the obliteration of surface deposits, geology is in confusion, plant and animal life serves both biology and meteorology like a vast thermometer actually recording within a few degrees the repeated rise and fall of temperature. This record consists of the invading and retreating life waves of river, forest, field, barren ground, steppe, tundra and arctic types, with increasing cold, or the reversed order, with diminishing cold, in the same localities or geographical areas. There seems to be sufficient evidence for a main division of the Pleistocene as follows :

Upper Pleistocene = *Postglacial.*

Middle Pleistocene { Upper / Middle / Lower } *Glacial.*

Lower Pleistocene = *Preglacial.*

Briefly the prevailing views in Europe as to the glacial age are told in Chart V.

(1) The preglacial stage presents a mingling of south temperate, temperate and northern forms of mammals.

(2) The long first glacial advance was followed (Pohlig) by the Rixdorf stage, intermorainal, colder than the succeeding Mosbach and Thuringian stages which have a more temperate facies in the recurrence of some of the Forest Bed Fauna.

(3) The faunal evidence for a colder mid-glacial period is conclusive. The evidence for a second or mid-glacial advance, between the first and last great glacial stages, is mainly biological, that is, subarctic are followed by more temperate life forms, as we gather largely from studies of the rodent fauna by Nehring, Studer and others. The hypothesis of three distinct glacial advances and of two inter-glacial retreats rests therefore upon a combination of geological and biological evidence which is not as yet conclusive.

* A Titanothere is reported in Roumania.

(4) There followed the postglacial, neolithic, alluvial stage.

Geographically the beginning of the Pleistocene is remarkable for its *broad land connections* and it represents the last stage of that community of fauna which during the Pliocene distinguished the entire region of Europe, Asia, Africa and North America. These connections may all be restored by raising the continents to the 200-meter or 100-fathom line as shown in Chart II. The mid-Pleistocene period in Europe is mainly one of *continental depression;* (1) at the climax of the first glacial advance extensive portions of northern Europe were submerged beneath the sea, (2) at the close of the first interglacial or temperate period (*Elephas antiquus* stage, Pohlig) occurred

CHART V.

PARTLY THEORETICAL DIVISIONS OF EUROPEAN PLEISTOCENE, AFTER POHLIG, DEPÉRET, NEHRING AND OTHERS.

I. Main Stages.	II. Partly Theoretical Relations of Glacial Oscillations.	III. Characteristic Geological Deposits.	IV. Faunal Div. (Pohlig.) Localities. Climate. Gen. Fauna. Stratigraphical Faunal and Geological Succession.	V. Human Remains and Characteristic Mammals.
Neolithic implements.	Recession of Glaciers.	Humus, Lake Terraces. Post-Glac. Löss.	**Prehistoric Stage.** N. temperate. Forest, Upland, River and Field Fauna.	**Forest and Lake Dwellers.** Recently exterminated types.
UPPER PLEISTOCENE. Post-Glacial or Alluvial.				
(Moustiéren Human type.)	3d Glacial.	Löss, Valley Gravels, Cave Clays, Diluvium, Sands.	**Elephas primigenius stage.** N. Temperate and Boreal, Steppe and Forest Fauna. Up. Rodent, Steppe Fauna, Yellow Culture Layer; Lower Rodent Tundre Fauna. Subarctic Tundre Fauna. RHINOCEROS MERCKII.	**Neanderthal and Spy, human types. Steppe and Cave Dwellers.** Felis, Hyæna, Ursus spelæus, Cyon alpinus, Capra ibex, Ovibos, Rangifer, Bison priscus, Equus, R. tichorhinus, Elasmotherium, Elephas primigenius.
	2d Interglacial.			
Palæolithic implements.	2d Glacial.			
MIDDLE PLEISTOCENE. Glacial or Diluvial. (Chelléan Human type.)	Interglacial. 1st Interglacial.		**Elephas antiquus stage.** N. Temperate Thuringian tufa, Taubach (Weimar)	**Oldest human remains known, Molar teeth** (Nehring). Saiga prisca, Alces machlis, Capreolus, Lemmus, Alactaga saliens, Lepus, Elephas antiquus, E. primigenius, Rhinoceros merckii.
		Fluviatile, River Sands, and Gravels.	**Elephas trogontherii** Temperate. B. Mosbach Sands (Lower Terraces).	Felis spelæa, F. lynx. Bison, Sus scrofa, Cervus elaphus, Equus caballus, Rangifer, Hippopotamus, Arctomys.
		Gravels, Conglomerates, Sands.	A. Rixdorf Beds, Subarctic.	Megaceros, Ovibos, R. tichorhinus, R. merckii, Elephas trogontherii.
	1st Glacial.	Boulders. Erratics, Clays, Drift, Sea-terraces, Moraines.	Arctic.	Fauna unknown.
LOWER PLEISTOCENE. Preglacial or Transitional to Pliocene.	Advance of Glaciers.	Estuarine and Fluviatile, Marls and Sands.	**Elephas meridionalis stage.** Forest Beds (Norfolk). St. Prest. Durfort. Malbattu (Auvergne Puy de Dome). Chalon-St. Cosme (Bresse).	**Earliest palæoliths.** Machærodus, Hyæna spelæa, Ursus spelæus, Lutra, Ovibos, Hippopotamus, Bos primigenius, Equus stenonis, Rhinoceros etruscus, Elephas meridionalis, E. antiquus, Trogontherium.

the volcanic disturbances in Central Europe and the hot spring formation of Thuringia (Taubach, Weimar); at this time *all the old continental connections characteristic of the Tertiary and serving as land bridges for free Holarctic Oriental and Ethiopian migration began to break up in the following manner.* During the early mid-Pleistocene or *Elephas antiquus* stage (Pohlig) the English channel broke through the long pre-existing land-bridge between England and France; Great Britain was faunally isolated; similarly the Irish Channel was depressed and Ireland (Scharff, 1894) lost its land connection with Wales in the early Pleistocene and with Scotland in the newer Pleistocene. In the Mediterranean region, also, at the close of the first interglacial period (Pohlig), the land-bridge across Gibraltar, also that between Italy, Sicily and Africa was broken; Malta was isolated as an island and the great *Elephas antiquus* dwindled into the small insular type *E. melitensis.* To the eastward the Mediterranean Sea extended over the Ægean plateau, which had previously been terra firma, and the new Ægean Sea cut off the land connection between Greece and Asia Minor.

I. *Preglacial. Elephas meridionalis Period.*

The typical preglacial deposits are the *Forest Beds* of Norfolk, England. The weight of opinion and of fact is all upon the side of considering these beds as Pleistocene. From the lists given by Dawkins, Schlosser and other writers, the Preglacial period is found to contain:

12 Pliocene species.
32 Pleistocene species and races, now extinct.
17 Living species, of which 7 are Insectivora and Cheiroptera.

The most remarkable feature of this fauna is the mixture of African and North Asiatic forms. The great *Elephas meridionalis* a precursor of the Mammoth, is the most characteristic type. The first traces of man in the paleolithic flints of the Chéleen type occur upon this level.

The climate, judging by the flora and Conchylien fauna, was somewhat cooler than that of the upper Pliocene. The first arctic flora in England is in a layer which separates the *Forest Bed* from the glacial Boulder Clays. To this period, according to most authorities, the *Pithecanthropos erectus* of Dubois belongs. Others, including the late Professor Marsh, consider this link between man and apes, of Pliocene age.

II. *Glacial and Interglacial, or Mid-Pleistocene.*

1. *Lower Mid-Pleistocene. Lower Stage.*—In climate the early part of this period, immediately during and succeeding the ice period, was very extreme. None of the first ice period fauna is known unless we except *Elephas (primigenius) trogontherii* or *E. intermedius* and the red deer, *Cervuselephas*, the latter being doubtfully recorded from the Boulder Clay of England. Here, in the Rixdorf beds, we find the first arctic and subarctic types of animals in central Europe.

Middle Stage.—This stage (Mosbach Sands, Essex) marks the recurrence of a *more temperate climate*, first observed by Lyell and Evans in England and abundantly known in Germany and France. Two only of the characteristic Pliocene species recur, the hippopotamus and straight-tusked elephant. These alone have been universally cited as evidence of a south temperate or even of a tropical climate, but the more numerous hardy types which are found in this stage constitute still stronger proofs of a north temperate climate.

Geologically the deposits are of fluviatile origin consisting of river sands and gravels containing *Hippopotamus, Rhinoceros merckii* and Mammoth. The great beaver, *Trogontherium cuvieri* makes its last appearance here. *Geographically* the southern continental depression has not begun and the Lower Pleistocene land bridges persisted.

The Mosbach and Essex fauna give the following percentages:

4 Pliocene species (including two living types).
7 Pleistocene species, now extinct.
16 Living species (including 2 Pliocene species).

The characteristic Pleistocene types which are first recorded in Mosbach are early varieties of the Irish, Red and Roe deer, the moose and the cave lion, *Felis spelæa*. Among the living species recorded for the first time or making their first appearance at this stage are the Reindeer, Boar, Horse, Lynx, Badger and Marmot.

Upper Stage.—According to Pohlig, the mid-Pleistocene proper, or succeeding stage, was characterized by volcanic disturbances in central Europe and by the deposition of gypsum and tufas. Probably these earth movements were connected with the marked geographical changes brought about by wide-spread depression of the continental borders and isolation, which the same author assigns to this period. The fauna, typically represented in the Thuringian tufas, indicates a cooler or north temperate climate. *Elephas antiquus* is very abundant, making its last appearance north of Italy. The typical locality is the Thuringian tufa in which Pohlig records 61 species. Parallel with this is the Taubach, near Weimar fauna.

In 1895 Nehring reported from this level what he regarded as the *oldest human remains* thus far found in Europe, consisting of two very large molar teeth resembling in some respects those of the Chimpanzee; this man he considered of the Chéleen type. In the same year Newton described a human skeleton of Esquimaux type in the still older 'Higher Terraces' or Hippopotamus level of Kent, England. The antiquity of this skeleton is, however, rendered somewhat doubtful by the fact that the skull is of much newer type than those of Neanderthal and of Spy, and the evidence for its extreme paleolithic age is not considered absolutely conclusive.

The faunal list is provisionally analyzed as follow:

3 Pliocene species still living (Castor, Hyæna, Arvicola).
7 Pleistocene species, now extinct.
23 Living species (including living Pleistocene Northern types).

The number of recorded living species increases, there being a marked increase especially in the number of Reindeer. The most important new living types are: the steppe antelope, *Saiga prisca* (*tartarica*), the moose, *Alces machlis*, the lemming, *Myodes lemmus*, the Siberian jerboa, *Alactaga saliens*, the porcupine, *Hystrix*, the rabbit, *Lepus timidus*. These constitute a distinct invasion of north Asiatic forms to the southern steppes.

2. *Upper Mid-Pleistocene or Elephas primigenius Stage Pohlig.*—As we enter the next succeeding Loess and Cave Period of Central Europe, the main life stage of the mammoth, *Elephas primigenius*, the wooly rhinoceros, *Rhinoceros antiquitatis* or *tichorhinus*, and the reindeer *Rangifer tarandus*, we note the decline of the broad-nosed rhinoceros *Rhinoceros merckii* and the absence of the straight-tusked elephant *Elephas antiquus* in geological deposits which are chiefly diluvial gravels, and sand clays. These facts alone indicate a prolonged colder period, a north temperate or boreal climate. The fauna presents a great variety adapted to different degrees of temperature but decidedly of northern type. Other facts indicate that this colder period was initiated by a distinct advance of the ice followed by a gradual recession, namely, the occurrence of arctic and sub-arctic types succeeded by north temperate types, in a number of localities, typically near Schaffhausen. (Nehring, Steinmann, Schlosser.)

These successive northern faunas in single localities are typically as follows: 1. Tundre Fauna; 2. Steppe Fauna; 3. Forest Fauna.

Europe now included a most remarkable diversity of life of Asiatic, North Siberian, Oriental and African origin. The climate was cold and relatively dry. The Reindeer, first the barren ground then the woodland variety, increased rapidly in number during this period and constituted its most distinctive form, hence this is known as the Reindeer period.

This stage is famous for the skeletons of man, the man of Néanderthal and Spy, very primitive in the structure of the skull, the oldest human skeletal remains with the exception of the *Pithecanthropus* of Java.

III. *Upper Pleistocene. Postglacial.*

As above observed there is a difference of opinion as to the interglacial or postglacial age of the loess. All the North Siberian, Oriental and African types gradually disappear, the modern European forest and field fauna alone survives. There is some evidence that both the Mammoth and Reindeer lived for a time in this period, the latter being now confined to more northern Europe. The Irish deer, *Megaceros hiberniæ* the Reindeer, the bovidæ *Bos taurus, Bos longifrons,* and *Bos brachyceros*, are the characteristic ruminants. *Alces palmatus* is a postglacial Russian moose. The horse, *E. caballus,* of larger and smaller varieties was now domesticated and used for food. The carnivora, rodentia and insectivora were all of modern type.

The detailed comparison of the Pleistocene of Europe, America and Asia is still under way, and very important results may be expected from it. It will be equally serviceable to American anthropologists and paleontologists, for our own Pleistocene is far from being understood. The stages represented by our horse or *Equus Beds,* which are usually considered Lower Pleistocene, as well as of the Megalonyx and Cave Fauna of the East remain to be exactly fixed. Interest in this problem is greatly enhanced by the fact that we may at any moment discover the remains of man or of his ancestors associated with *Equus excelsus* and positively demonstrate the existence of man upon this continent at a period contemporaneous with his first appearance in Europe.

Henry Fairfield Osborn.

CRUISE OF THE ALBATROSS.

IV.

Mr. Agassiz's final letter to the U. S. Fish Commission on the voyage of the *Albatross* is dated Yokohama, Japan, March 5, 1900.

After coaling and refitting we left Suva on the 19th of December, and arrived at Funafuti on the 23d, stopping on the way at Nurakita, the southernmost of the Ellice Islands. I was, of course, greatly interested in my visit of Funafuti, where a boring had been made under the direction of a committee of the Royal Society, in charge of Professor David, of Sydney, after the first attempt under Professor Sollas had failed. The second boring reached a depth of more than 1100 feet. This is not the place to discuss the bearing of the work done at Funafuti, as beyond the fact of the depth reached we have as yet no final statement by the committee of the interpretation put upon the detailed examination of the core obtained, and now in the hands of Professor Judd and his assistants. In addition to the above-named islands, we also examined Nukufetau, another of the Ellice group.

After leaving Nukufetau we encountered nothing but bad weather, which put a stop to all our work until we arrived under the lee of Arorai, the southernmost of the Gilbert Islands. On our way to Tapateuea from there we steamed to Apamama and Maiana, which we examined, as well as Tarawa. We next examined Maraki, an atoll which is nearly closed with high

beaches, having only two small boat passages leading through the narrow outer land-rims. Both Maraki and Taritari, the the last island of the Gilberts which we examined, are remarkable for the development of an inner row of islands and sandbars in certain parts of the lagoon parallel to the outer land-rim, a feature which also exists in many of the Marshall Islands atolls.

We reached Jaluit the 9th of January, and after a few days spent in coaling, we spent about three weeks in exploring the Marshall Islands, taking in turn the atolls of the Ralick Chain to the north of Jaluit: Ailinglab Lab, Namu, Kwajalong, and Rongelab; and then the atolls of the Ratack Chain, Likieb, Wotje, and Arhno. The atolls of the Marshall Group are noted for their great size and the comparatively small area of the outer land-rims, the land-rims of some of the atolls being reduced to a few insignificant islands and islets. In none of the atolls of the Ellice, Gilbert or Marshall Islands were we able to observe the character of the underlying base which forms the foundations of the land areas of these groups. In this respect these groups are of striking contrast to the Paumotus, the Society Islands, the Cook Group, Niue, the Tongas, and the Fiji Islands where the character of the underlying foundations of the land-rims is readily ascertained. But, on the other hand, these groups give us the means of studying the mode of formation of the land-rims in a most satisfactory manner, and nowhere have we been able to study as clearly the results of the various agencies at work in shaping the endless variations produced in the islands and islets of the different atolls by the incessant handling and rehandling of the material in place, or of the fresh material added from the disintegration of the sea or lagoon faces of the outer land, or of the corals on the outer and inner slopes. It has been very interesting to trace the ever-varying conditions which have resulted in producing so many variations in the appearance and structure of the islands and islets of the land-rims of the different groups.

The boring at Funafuti will show us the character and age of the rocks underlying the mass of recent material of which the land-rim, not only of that atoll, but probably also that of the other atolls of the group and of neighboring groups, is composed, though of course we can only judge by analogy of the probability of the character of the underlying base from that of the nearest islands of which it has been ascertained. When we come to a group like the Marshalls we have as our guide only the character of the base rock of the islands of the Carolines, which is volcanic, while Nauru and Ocean Islands, to the west of the Gilberts and to the southwest of the Marshalls, indicate a base of ancient tertiary limestone.

Owing to the continued stormy weather and the probability of not being able to land at these islands while the unfavorable conditions lasted, we did not attempt to visit them.

After leaving Suva we made a number of soundings from south of Nurakita toward the Marshall Group, which, in addition to those of the 'Penguin,' clearly show that the Ellice Islands are isolated peaks rising from considerable depths (from 1500 to over 2000 fathoms) and that the same is the case with the Gilbert Islands. We made about thirty soundings between the atolls of the Marshalls, which appear to show that they also rise as independent peaks or ridges, with steep slopes, from 2000 to 2500 fathoms, and that the so-called parallel chains of atolls of the Marshalls, the Ralick and Ratack, are really only the summits of isolated peaks rising but a few feet above the sea-level. The Marshall Islands, as well as the Ellice and

Gilbert, seem to be somewhat higher than the Paumotus, but this difference is only apparent and is due to the difference in the height of the tides, which is very small in the Paumotus, while in these groups it may be five and even six feet.

From Jaluit we visited among the Carolines, the islands and atolls of Kusaie, Pingelap, Ponapi, Andema, Losap, Namu, the Royalist Group, Truk and Namonuito, obtaining thus an excellent idea of the character of the high volcanic islands of the group from our examinations of Kusaie and of Ponapi, while the others represent the conditions of the low atolls, having probably a volcanic basis, but this was not observed at any of those we examined.

The reefs of the volcanic islands of the Carolines are similar in character to those of the Society Islands, though there are some features, such as the great width of the platforms of submarine erosion of Ponapi and of Kusaie, and the development of a border of mangrove islands at the base of the volcanic islands, which are not found in the Society Islands.

The Truk Archipelago was perhaps the most interesting of the island groups of the Carolines, and it is the only group of volcanic islands surrounded by an encircling reef which I have thus far seen in the Pacific which at first glance lends any support to the theory of the formation of such island-groups as Truk by subsidence. This group was not visited by either Darwin or Dana; and I can well imagine that an investigator seeing this group among the first coral reefs would readily describe the islands as the summits, nearly denuded, of a great island which had gradually sunk. But a closer examination will readily show, I think, that this group is not an exception to the general rule thus far obtaining in all the island groups of the Pacific I have visited during this trip; that we must look to submarine erosion and to a multitude of local mechanical causes for our explanation of the formation of atolls and of barrier and encircling reefs and that, on the contrary, subsidence has played no part in bringing about existing conditions of the atolls of the South and Central Pacific.

Nowhere have we seen better exemplified than at Truk how important a part is played by the existence of a submarine platform in the growth of coral reefs. The encircling reef protects the many islands of the group against a too rapid erosion, so that they are edged by narrow fringing reefs, and nowhere do we find the wide platforms so essential to the formation of barrier reefs. The effect of the northeast trades blowing so constantly in one direction for the greater part of the year is of course very great; the disintegration and erosion of islands within its influence is incessant, and their action undoubtedly one of the essential factors in shaping the atolls of the different groups, not only according to the local positions of the individual islands, but also according to the geographical position of the groups. Thus far I do not think any observer has given sufficient weight to the importance of the trades in modifying the islands within the limits of the trades, nor has anyone noticed that the coral reefs are all situated practically within the limits of the trades both north and south of the equator.

The soundings made going west from Jaluit to Namonuito indicate that there is no great plateau from which the Carolines rise, but that the various groups are, as is the case with the neighboring groups of the Marshalls and Gilberts, isolated peaks with steep slopes rising from a depth of over 2000 fathoms. The line we ran from the northern end of Namonuito to Guam developed the eastern extension of a deep trough running south of the Ladrones. The existence of this trough had been indicated by a sounding of 4475 fathoms to the south-

west of Guam made by the *Challenger*. We obtained, about 100 miles southeast of Guam, a depth of 4813 fathoms, a depth surpassed only, if I am not in error, by three soundings made by the *Penguin* in the deep trough extending from Tonga to the Kermadecs.

I was very much surprised, in approaching Guam from the eastward, to find that the island was not wholly volcanic, but that the northern half has been built up of elevated coralliferous limestone. The vertical cliffs bordering the eastern face rise from a height of 100 to 250 or 300 feet at the northern extremity, and resemble in a way similar islands in the Paumotus (Makatea), Niue, Eua, Vavau and others in the Fijis which had made their cliffs a familiar feature in our explorations. In fact, outside of Viti Levu and Vanua Levu, this is the largest island known to me where we find a combination of volcanic rocks and of elevated coralliferous limestone. The massif forming the southern half of the island is volcanic, and the highest ridge, rising to about 1000 feet, runs parallel to the west coast, the longest slope being toward the east.

This volcanic mass has burst through the limestone near Agaña, and the outer western extension of the coralliferous limestone exists only in the shape of a few spurs running out from the volcanic mass, the largest of which are those forming the port of San Luis d'Apra. These spurs are separated by lower ridges of volcanic rocks extending to the sea from the main central mass. To the north of Agaña the limestone forms an immense irregular mesa, cut by deep crevasses, full of pot-holes and sinks, rising gradually westward to a height of 350 or 400 feet. Near the northern extremity of the island a volcanic mass, Mt. Santa Rosa, has burst through the limestone and rises about 150 feet above the general level of that part of the island. The shore stratification of the bluffs is much distorted in the vicinity of that volcanic outburst.

We left Guam in time to reach Rota by day, and found that this island is a mass of elevated coralliferous limestone, the highest cliffs of which reach a height of 800 feet. Perhaps in none of the elevated islands have we been able to observe the terraces of submarine elevation as well as at Rota, especially in the small knob at the southwest point of the peninsula separating Sosanlagh and Sosanjaya bays, which itself is also terraced; no less than seven distinct terraces could be traced. There was no sign of any volcanic outburst except at the northwest point of the island, where both the character of the slope and of the vegetation would seem to indicate volcanic structure.

It is quite probable that others of the Ladrones, like Saipan, and the islands to the south, are composed in part at least of elevated limestone judging from the hydrographic charts and the sketches which accompany them. On many of the northern Ladrones there are active volcanoes, so that it is very possible that the volcanic outbursts which have pushed through the limestone, or have elevated parts of the islands of the group, are of comparatively recent date.

During the last part of our cruise, from Suva to Guam, the unfavorable weather greatly interfered with our deep-sea and pelagic work; in fact, with the exception of the soundings made to develop as far as practicable the depths in the regions of the various coral-reef groups we visited, we abandoned all idea of carrying out the deep-sea and pelagic work planned for the district between the Gilbert and Marshall and Caroline groups. To our great disappointment hardly any marine work could be accomplished, and our investigations were limited almost entirely to the study of the coral reefs of the regions passed through.

After Mr. Townsend's departure, Dr.

Moore continued to collect the birds of the islands where we anchored, and they have brought together a fairly typical collection of the avifauna of the South Sea Islands. Dr. Pryor collected the characteristic plants, and Dr. Mayer the insects and reptiles in addition to such pelagic work as could be done in port. Both Dr. Woodworth and Dr. Mayer took a large number of photographs, and we must have at least 900 views illustrating the coral reefs of the Pacific. Dr. Woodworth also collected incidentally such ethnological material as could readily be obtained during our short stay at different places.

We were everywhere received with the greatest cordiality and courtesy: by the Governor of the Paumotus, the King of Tonga, Sir George O'Brien (the High Commissioner of the Western Pacific at Suva), Mr. E. Brandeis (the Landes-Hauptman in charge of the Marshall Islands at Jaluit), and the Governor of the Carolines. The State Department at Washington having kindly asked through the French, English and German Embassies at Washington for the kind offices of the representatives of these nations in Oceania to the *Albatross* while in their respective precincts, thanks to these credentials nothing could exceed the interest shown everywhere in the success of our expedition.

I must also thank Capt. Moser and the officers of the *Albatross* for the untiring interest shown by them during the whole time of our expedition in the work of the ship, which was so foreign to the usual duties of a naval officer. A. Agassiz.

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*THE PRESENT STATE OF PROGRESS OF THE NEW REDUCTION OF PIAZZI'S STAR OBSERVATIONS.**

Between the years 1791 and 1814, Giuseppe Piazzi executed at Palermo, Sicily, the series of observations which enabled him to publish in 1814 his *Præcipuarum Stellarum Inerrantium Positiones Mediæ ineunte Sæculo XIX.* This was by far the most accurate and extensive catalogue of stars which had ever been published from original observations. But modern advances in this sphere of astronomical research have been fruitful in detecting many sources of error affecting the positions of stars as given in this catalogue. Methods for obviating these errors are known, however, provided there should be an entirely new reduction of all the observations—proceeding directly from each nightly record.

Several abortive attempts to supply this need of astronomy have been made during the last half-century. The impetus was given to the present undertaking by the writer in the summer of 1895, though the calculations were not actually begun until the fall of 1896.

Quotations from letters from such eminent astronomers as Professor Auwers, Dr. David Gill, Professor Schiaparelli, and others; and from the published works of Professor Simon Newcomb, Professor Lewis Boss, Dr. B. A. Gould and many others, show the imperative need of such a new reduction of Piazzi's observations.

In planning a work of this kind, after regard for general methods the first consideration becomes the quantity of work involved—as on that depends the financial outlay and the best disposition of energy. Some data on this point may be of interest.

The observations were made with two instruments: a transit instrument and a meridian circle. The catalogue records a few more than 147,600 observations with both telescopes. Of these Piazzi* himself estimated that 30,000 were made with the transit. The original observations are in

*Summary of a paper read before the Philosophical Society of Washington on March 31, 1900.

* Corrispondenza Astronomica fra Giuseppe Piazzi e Barnaba Oriani—letter of 26 May, 1815.

the *Storia Celeste* * and it is safe to say that they will number 150,000. There are in the catalogue 7646 stars and in the *Storia Celeste* 216 more which had been discarded.

At the very beginning of the work the co-operation of Professor Porro of Turin was secured. Some years ago he had begun, while assistant to Professor Schiaparelli at Milan, an investigation of the independence of the observations on the transit instrument. By reason of his interest in that question and the work already done in connection therewith, he very readily consented to become responsible for the reduction of all the observations of the transit instrument while the writer assumed responsibility for all the observations on the Meridian Circle and the rest of the new reduction.

For the reduction of these latter 120,000 observations the work naturally is divided into parts depending on the process to be performed. The computation sheets for each process have been designated respectively as Form A, Form B, etc. The number of pages in each Form range from 386 to 8000 and are $8\frac{1}{2}$ by 11 inches in size. There are already printed and partly or wholly filled 22,500 such pages in the following Forms:

A. Journal of Notes, constants, methods, etc. ? %
B. Day-book and provisional reduction to 1800 10 %
C. Besselian Star-constants for 1800.....100 %
D. Tabulated values of the star-constants....100 %
E. Interpolated values of the day-numbers..100 %
F. Reduction from Apparent to Mean place ...40 %
H. Compilation of positions by other observers for deduction of proper motions .....10 %
M. Miscellaneous tables and short computations ? %

The percentage at the end of each line shows approximately the amount which is already accomplished. By very careful methods of checking endeavor is made to avoid numerical incorrectness, and though the work is being pushed with all energy possible, it is not being done in haste at the expense of accuracy.

It is a pleasure to record the zeal with which co-operation has been secured along several lines not strictly included in the direct operation of newly reducing Piazzi's observations, though vitally connected therewith. A re-observation of all Piazzi's stars for especial use in determining their proper motions has been undertaken (and is already far on its way towards completion) by Professor J. G. Porter of the Cincinnati Observatory and Professor R. H. Tucker of the Lick Observatory. Miss Flora E. Harpham and Professor Susan J. Cunningham are performing all the labor of compiling the star positions from other catalogues for deduction of proper motions. Others are doing other useful parts of the reductions and checkings.

So long ago as 1866, when writing the preface to his own reduction of D'Agelet's observations, Dr. B. A. Gould made the following statement:

"In addition to the motives already mentioned as having prompted me to undertake this reduction and catalogue, an especial incentive was found in the experience which it would afford and make available for a much more extended work which has long been a cherished project, a recomputation of Piazzi's observations and the formation from them of a new catalogue. This is an enterprise far too extensive for the powers of a private individual, but I look forward with much hopefulness to the possibility of obtaining the requisite means at some future time . . . No astronomical labor promises richer usefulness than this; and if the great work of reducing anew the observations of Bradley be carried out by a combination of the astronomers of Europe, as is now proposed, nothing seems more appropriate for the astronomers of the New World than to render a similar service by a new reduction of the *Storia Celeste*."

This statement is even more true now than when first written. Not alone have the observations of Bradley been newly reduced by Professor Arthur Auwers and published twelve years ago, but a new reduction of Mayer's catalogue was pub-

* Nine volumes published by Littrow at Vienna, 1845–49.

lished by the same eminent authority in 1894. A new reduction of Taylor's 11,015 stars is expected soon to appear from the Nautical Almanac Office of England. Thus the most important old catalogue which needs to be newly reduced is Piazzi's: and the object of my remarks has been to show that at the present moment a vast amount of the work incident thereto *is already accomplished.* Thanks to the generosity of Miss Catharine W. Bruce, of New York City, financial assistance was rendered for the employment of computers between June, 1898, and January, 1900, whereby much of this result was attained. But now the possibility of its completion rests not so much in the faithful persistence of those engaged in the computations as in the additional generosity of other patrons of astronomy, and in the continued encouragement which so many Observatories and individual astronomers have thus far seen fit to so kindly bestow.

Herman S. Davis.

Washington, D. C.

SCIENTIFIC BOOKS.

Scientific Papers. By John William Strutt, Baron Rayleigh, D.Sc., F.R.S. Vol. I., 1869–1881. Cambridge at the University Press. 1899. Quarto, pp. i–xv., 1–562. New York, The Macmillan Co. Price $5.00.

In endeavoring to review this first volume (1869–1881) of the researches of an author like Lord Rayleigh, who has contributed fundamentally to whatever he has undertaken, and who speaks authoritatively on almost every topic in physics; in whose work, in other words, both the quality and the quantity are in evidence, it would be rash to attempt to give more than an outline of the contents. The papers moreover, are in general too severely difficult to be read as a whole, and there are no figures or diagrams (or almost none) to assist the imagination, no italics to stimulate curiosity. Many of the papers are theorems in pure mathematics, but in few cases (contributions to the mathematical tripos examinations, for instance) is the mathematical story left unadorned by the moral of an application. Lord Rayleigh is pre-eminently a physicist, and mathematics with him is good means to a better end.

The book opens (1869) with papers on the applications of dynamics to electro-magnetic phenomena, showing the influence of the inspiration of Maxwell and worked out along Maxwell's lines. Thus the analogy between the decomposition of water, produced or not produced according as the circuit of a Daniell's cell (alternately made through a shunt and broken through the electrolyte) contains a coil or not, and the action of an hydraulic ram, the analogy between the spark and the rupture of the pipe, etc., are all in the spirit of an accentuation of Maxwell's conception of electric inertia, long before Lodge had popularized that doctrine. The investigation leads to a consideration of circuits containing self induction and capacity, and is carried through two long papers largely experimental in character and similar to Henry's researches on the magnetization produced by oscillatory currents.

Then follow two papers on acoustics beginning a subject destined to culminate in 1877 in the well known work on sound, which like de St. Venant's elastics, has remained without a compeer. The shorter paper completes Sondhauss's theory on the influence of the size and the form of flasks on the sounds produced when a current of air is blown across their mouths, with the aid of Helmholtz's famous research on the vibration of open organ pipes. The longer is the great paper on the theory of resonance, published in three parts in the *Philosophical Transactions* of 1870. Rayleigh here also begins with Helmholtz's results for 'Hohlräume,' using a parallel but thoroughly different mathematical treatment. Part I. contains the general dynamics for resonators of small dimensions compared with wave length, and communicating with the air by any number of holes or necks, usually along an infinite plane, and a final application to the open organ pipe is sketched out. Part II. is devoted to the special problems relating to necks, etc., suggested in Part I. The neck is here considered relative to its 'resistance' to vibration, and the pertinent electrical analogy is used

throughout the discussion. In part III. the theoretical deductions are verified by experiment for such cases as admit of accurate numerical computation. Much of this theory is embodied in the second volume of 'Sound' (16th Chapter).

After this Lord Rayleigh's mind seems to have been intensely attracted by optical phenomena, and we find first a critical examination of Verdet's diffraction theory of the solar corona, followed by a long experimental paper confirmatory of Maxwell's theory of color perception. The experiments aim at establishing the linear equation between any four colors with a higher degree of accuracy. They are made with Maxwell's educationally now very familiar color wheel. In 1871 came the two papers dealing with the dynamics of the blue sky, perhaps the most famous of Lord Rayleigh's theoretical researches. It is needless to refer to them at length here, since an easily intelligible presentation is given in Preston's theory of light (Art. 162). If the long waves are absorbed on transmission and the short waves scattered, the blue color of the sky is naturally a manifestation of the surviving mean wave lengths. Clausius, it appears, had previously developed an interferential theory to account for the same phenomenon at considerable length, but had subsequently rejected it chiefly because in the case of particles small in all their dimensions as compared with the wave length of light the ordinary laws of reflection no longer hold and an independent investigation is imperative. Without being aware of these misgivings, Rayleigh took up and completed the subject from the point where Clausius * left it. The former has frequently recurred to the same investigation, showing in a recent paper, for instance, that scattering may even be promoted by the molecules of air themselves.

Of the two optical papers which follow, the first, a theory of double refraction based on the hypothesis of difference of molecular inertia in different directions (given for instance by the case of a disc vibrating in a resisting fluid), seems to have been disproved shortly after in experiments of Stokes's. The other is an elaborate contribution to Fresnel's fundamental investigation on the intensity of light reflected from transparent media. Fresnel's expressions have been remarkably suggestive, and they are approximately true. The method by which the tangent formula is derived, however, is not rigorous, and he was of course unaware of Jamin's discovery of the change of phase which accompanies reflection. Green's, Cauchy's, MacCullagh's, Neumann's, and Lorentz's theories are successively examined, but the nature of the correction (Fresnel's result predicts extinction at the angle of polarization), or a derivation which shall satisfactorily dispose of the longitudinal wave is not ascertained. All this recalls Lord Kelvin's Baltimore lectures. A subsequent paper on the reflection of light from opaque matter is much along the same lines, being critical rather than constructive. It is curious that a man of Rayleigh's genius instead of wrestling with these abstruse elastic theories did not make an entirely new departure from the basis of the electromagnetic theory* of light, as did afterwards Helmholtz in his famous paper on dispersion.

At about this time the reproduction of diffraction gratings by photography, a fascinating subject engaged Lord Rayleigh's attention, and as in most of his work, grew eventually into an extended treatment of the degree of perfection attainable in gratings. Transparent gratings of Nobert, with 3000–6000 lines to the inch were found directly reproducible when used as negatives, and the copies proved nearly equal in quality to the original, showing for instance, the nickel line between the D's. Gelatine reproductions (obtained by the photolithographic process with chromate of potassium)

* To me it seems probable that these researches of Clausius may be resuscitated in relation to the colors of cloudy condensation. As seen in the color tube by transmitted light, the yellows, oranges, browns, of the first order, ending eventually in opaque are undoubtedly Rayleigh's colors. The jet in reflected light is bluish. Beyond this, with increasing size of particles, the transmitted colors are violet, blue, green, yellowish, purple, etc., following Newton's color series, and to these, it would seem, that Clausius's investigations are applicable. I shall return to this interesting subject elsewhere.

* Although Maxwell's electricity was not completed until 1873, one would suppose that the contents could not be quite unknown to Rayleigh.

surpassing the Nobert plate in brilliance also succeeded. Since to resolve the D lines the distance between the rulings must be true to 1/1000, this performance seems incredible. Yet Rayleigh anticipates no limit to his method up to 10,000 lines to the inch. Copies of similar gratings made in accordance with Rayleigh's directions are found in most of our laboratories. They have not held their own owing to the enormous stride forward in diffraction spectroscopy due to the invention of Rowland's concave grating. Connected with these papers is one on the diffraction of object glasses in telescopes, in which the advantage of a central stop to cut off superfluous light without destroying the definition is succinctly laid down.

Of Lord Rayleigh's highly important contributions to mathematical literature made at about this time, bare mention only is possible here. A paper on some general theorems relating to vibrations deals with great breadth of method with the reciprocal character of forces and motions of any two types. To quote an illustrative example: If A and B are two points of a stretched string, a periodic transverse force at A produces the same vibration at B as would have ensued at A for a force acting at B. Another paper treats of the numerical calculation of fluctuating functions (Bessel functions, for instance, though the method has broader scope) when the usual expansions in series fail. Again the reciprocal properties of systems capable of vibrating about a position of equilibrium, is accentuated in a further paper put in form of a statical theorem. Of these powerful theorems (together with a parallel theorem of Helmholtz) Rayleigh frequently makes effective use, and reference to them occurs in other parts of the volume, either in relation to sound or to light. Finally, the proof of Thomson's theorem, that if a material system start from rest under the action of given impulses, the energy of the actual motion exceeds that of any other which the system might have been guided to take under the operation of constraints, etc., is recast in such a way as to suggest important corollaries.

Two papers on thermodynamics now appear.

It is Rayleigh's idea to utilize the fall of temperature between the furnace and the boiler as well as that between boiler and condenser by supplementing the steam engine with an auxiliary oil engine, and the development leads to a discussion of the doctrine of dissipation. Again the case where work may be gained by mixing gases, as for instance when hydrogen diffuses into air through a porous plug, is subjected to computation, by finding the work needed to separate a mixture. The line of reasoning adopted by Lord Rayleigh in this paper reminds one of the fundamental research of van't Hoff, though it breaks off with the isolated case under discussion. The interesting result is formulated that relatively more work is needed when the ingredient to be separated is present in small quantity.

At this point we come upon a series of distinctively hydrodynamic researches, beginning with a paper on gravitational waves. The case of the long wave in shallow water was solved by Lagrange, who showed that its velocity is identical with that of a heavy body falling half the depth of the canal. If the water itself moves with an opposed velocity, the wave form is of the steady type often observed in gutters conveying water. After enlarging the theory of long waves, Rayleigh applies it to find the effect on a stream of a contraction or a widening of the channel, to the case of the solitary wave (for which he finds a theoretical explanation agreeing with Scott Russel's observations. The solitary wave when positive, *i. e.*, an elevation, has considerable permanence. The negative wave on the contrary soon breaks up), to periodic water waves and to the oscillations of water in a cylindrical vessel.

This research is followed shortly after by an investigation of the resistance of fluids. Helmholtz had previously pointed out that finite slipping was left out of account on ordinary hydrodynamics. Rayleigh is induced to reopen the subject with the ulterior object of formulating the resistance encountered by a solid body floating in a stream. In the case of a plate it appears that the resistance to broadwise motion can be increased enormously by the superposition of an edgewise motion, a result of great value in aërial navigation. It recalls the striking results obtained by

Langley in the same direction. In a further paper the theory of the vena contracta and of colliding jets is subjected to analysis, in which (following Maxwell) the inferences are drawn directly from the principle of the conservation of linear momentum. To the question of jets, Rayleigh returns in succeeding papers. In the first of these the conditions of instability are discussed, both for capillary or statical instability, and for dynamic instability, such as occurs, for instance, in waves or surface of water under the influence of the wind. The other paper examines the capillary phenomena observed in jets issuing from an orifice which is not circular, but elliptic, triangular, etc. Apart from form, the wave lengths of the issuing stream have a close relation to the square root of pressure. Disposing of this case, Rayleigh then passes to the dismemberment of the circular jet into drops, or of an oblique jet into sheathes, using the experimental (shadow) method of Buff. A curious result of the analysis may be mentioned, viz, that the radius of the sphere which vibrates capillarly in seconds is about one inch. Rayleigh's more recent work with jets and ripples is not included in this volume, but interspersed among other hydrodynamic researches is the fascinating and well-known paper on the influence of electricity on colliding water drops, proving that whereas unelectrified drops rebound on collision, electrified drops coalesce. The conclusions are made more striking by the examination of paired jets, and an important inference is drawn relative to the growth of rain-drops stimulated by thunder storms. A further paper on the instability of fluid motions (the preceding cases being chiefly of interest in their relation to sensitive flames and smoke jets) reopens the whole question, obviating the preceding hypothesis of discontinuous fluid motion and admitting only such gradual changes of velocity as must inevitably occur in viscous liquids. A final paper is devoted to progressive waves, treating the case frequently observed that the group velocity of waves advancing into still water is often below the velocity of the constituent members of the group. The investigations are largely embodied in 'Sound.' They are referred to the case of two infinite wave trains of the same amplitude and nearly the same wave-length, superposed.

Meanwhile Lord Rayleigh has not lost interest in acoustical subjects. In a paper on our perception of the direction of a source of sound there occurs a humorous passage which is rare in his writings. "The efficient action of a lens" (for the purpose in question) "depends on its diameter being at least many times greater than the wave-length of light, and for the purposes of sight there is no difficulty in satisfying the requirement. The wave-length of the rays by which we see is not much more than a ten-thousandth part of the diameter of the pupil of the eye. * * * The waves of sound issuing from a man's mouth are about eight feet long, whereas the diameter of the passage of the ear is quite small, and could not well have been made a large multiple of eight feet." Usually the imputation of ears longer than 8 inches is regarded sufficiently undignified to be resented.

A similar paper with acoustical observations relating to binaural audition, reflection and interference of sound, pitch, etc., follows. Rayleigh then contributes to the few data then known of the amplitude* of the audible sound wave, by computing it roughly from the energy needed to blow a whistle and the distance of audibility, using a straightforward method which, like many others in the volume ought to find its way into our text-books. He finds the observed amplitude to have been of the order of $1/10^7$ centim., but believes the 1/40th part of it to be audible under favorable conditions. A paper on absolute pitch is concerned with the discrepancy observed between König's and Apunn's tonometers, which Rayleigh attributes to the mutual influence of simultaneously sounding reeds. He proposes a tuning fork clock method of his own. Another paper relating to Mayer's phenomenon of acoustic repulsion shows the pressure within a resonator to be in excess of atmospheric pressure, which is equivalent to a force at the mouth of the resonator directed normally inward. Then comes an original explanation of

* With the invention of Professor Webster's interferential apparatus this dearth has already become fruitful.

the effect of external influences in modifying vibrations, the former being grouped into such influences as modify pitch and those which encourage or discourage vibration. Thus in the latter case, an impulse would have to actuate a pendulum while passing through its position of equilibrium; in the first case the impulse must be applied at either elongation. The principle is illustrated in its bearing on the sounds frequently obtained in glassblowing, on the chemical harmonica, and on other similarly subtle methods of sound production. A second paper on absolute pitch accentuates the fact that two equations are given when the frequency-ratio and number of beats per second of two notes of a selected interval are given from which the absolute pitch of both may be computed. The inferences are tested with modifications by aid of the common harmonium. A new series of acoustic experiments deals with the production of pure tones from sounding flames on suitably modifying the resonator, with Savart's region of silence on reflection, with sensitive flames (which seem to fascinate Rayleigh as they did Tyndall and by which the remarkable investigations on jets above referred to were suggested), etc. Among the results we find that sensitive flames are excited at loops and not at nodes, that Rijke's notes (produced by heated gauze on cooling in a pipe) can be raised to an intensity sufficient to shake a room. Experiments are given on the effect of a barrier in promoting interference between the two halves of an organ pipe. In an ingenious experiment in which the chimney is made available as a source of draft, it is shown that the vibrations of the strings of an Æolian harp are at right angles to the direction of the wind. A final series of acoustic observations begins with the full discussion of Mayer's well-known experiment on intermittent sounds. After showing a new form of siren, an experiment is described for obtaining the interferential sound shadow of a circular disc, an analogue of the optical experiment. The last acoustical paper included is an explanation of the photophone.

The remaining papers of the volume are largely devoted to optics. We notice in particular a long and frequently quoted paper (1879–80) on the resolving power of telescopes with especial reference to spectroscopy.* Starting from the deductions of Airy, Verdet and others, Rayleigh computes the visibility curves for single and double lines, single and variously doubled slits. In an examination of the prismatic spectroscope it appears that the resolving power for a given glass is proportional to the total thickness traversed without regard to the number, angles or settings of the prisms. The aberration errors and the degree of accuracy required in the surfaces are abstrusely treated in detail and a final paragraph is devoted to the designing of the spectroscope. A subsequent theoretical paper deals with reflection when the transition at the boundary of two media is gradual and not abrupt as usually assumed by the great opticians (Fresnel, Green, Cauchy and others). Passing this and an experimental method (grating) of measuring the resolving power of telescopes, as well as another on the definition of images formed without lenses, we come to Rayleigh's first considerable papers (1881) on the electromagnetic theory of light. It would appear from this that Rayleigh like Kelvin was late in his acceptance of Maxwell's optics, certainly a regrettable circumstance by which the advance of science was retarded. It is the object of the present long investigation, to find an electromagnetic basis for Fresnel's optics, particularly in relation to reflection and to double refraction. In different ways Hemholtz, Lorentz, J. J. Thomson and others have all worked successfully at this problem. It is well known that to explain double refraction Fresnel postulated differences of rigidity of the ether in different directions; to explain reflection such a change of rigidity in passing from one medium to another is precluded. Neumann and MacCullagh have endeavored to obviate the inconsistency by replacing differences of rigidity by differences of density, but the elastic theory resulting is none the less imperfect. The electromagnetic theory of light based on radically different laws avoids these discrepancies at the outset. Naturally in Rayleigh's work the scattering reflection of moats is particularly considered as a test of

* In America, as we know, similar work has been remarkably promoted by the researches of Professor Michelson.

the equations deduced. In a following paper discussing Young and Forbes' experiments in which the velocity of violet light apparently exceeds the velocity of red light by 1.8 per cent., Rayleigh again accentuates the difference between the group velocity and the individual velocity of waves. The last optical paper in the volume reopens the question relative to the production of a truly compound yellow made of red and green, and treats other questions of similar psychological interest. The concluding paper of the book is an investigation in pure elastics, dealing with the infinitesimal bending of surfaces of revolution, with particular reference to the theory of bells.

I am of course well aware that the account which I have endeavored to give of this great book is altogether inadequate; but with such an exuberance of material, and so much of it expressed either in untractable equations or in a style admitting of expansion only, all attempts are foredoomed. Besides the larger papers which I have mentioned, there is a bewildering array of smaller articles, sententious criticisms or suggestions mathematical or not, theorems, special solutions, computations, etc. Some of Lord Rayleigh's most helpful services to science are to be found in these current notes and as a rule they are hard to find. For this reason the present complete republication of his works is additionally to be welcomed.

Rayleigh's style is exquisitely terse. Even those papers which are free from mathematics are not easy reading. The endeavor to make a clear statement more intelligible is rarely thought worth while. The greater number of papers are short. The average 7 pages each (78 papers in the 562 pages of this first volume). Withal it is a book to which one may come for fundamental originality, but one must expect to pay for the privilege. It is pleasant to note that Rayleigh cheerfully gives credit to the labors of others and not only to those of his own nation. But however genial his criticism it is none the less keen. Errors are virtually dismembered with a few deft strokes, and the incident passes before there is time to cry for mercy. On the whole a wise man will think twice before he disagrees with the author of these 'Scientific Papers.'

Lord Rayleigh is not quite as radical as some of the other English mathematicians in eschewing formulated mathematics as far as possible, a method which those of us who do not aspire to become too mathematical for mathematics, cannot but regret—at least when we have practical occasions for following the argument. There is moreover something amusing about this fashion of verbally treating abstruse mathematical doctrine. Our host, as it were, receives us at his ease, quite unarmed, and discusses the most delicate matters with complete nonchalance. But nobody is deceived. One may be quite sure that a strong man, armed cap-à-pie, is hidden away somewhere in the closet. When mathematics becomes verbal one feels that she is speaking a foreign tongue and that something is actually being translated. The original would be far preferable.

On closing the book one can not but wonder how much talk could be made out of a single page of it; or perhaps more graciously, how immensely science would be benefited if the bulk of what is now rampant were to shrink to the standard of Lord Rayleigh's text.

CARL BARUS.

BROWN UNIVERSITY,
PROVIDENCE, R. I.

System der Bakterien. By PROFESSOR W. MIGULA. Handbuch der Morphologie, Entwickelungsgeschichte und Systematik der Bakterien. Bd. II. Specielle Systematik der Bakterien. Jena, Gustav Fischer. 1900. Pp. 1068, pl. 18, figs. 35.

The working bacteriologist has long been in need of some treatise that would enable him to trace to the original description at least a fair proportion of the 'species' and 'varieties' that he finds referred to in the literature of the day. It is one of the great stumbling-blocks in bacteriology that a bewildering multiplication of names and synonyms has taken place during the last decade and has had its natural result in an almost hopeless confusion of bacteriological classification and nomenclature.

The great task essayed by Professor Migula may well command respect and admiration. Not only is enormous mechanical labor involved in the extracting and collecting of 1200

descriptions of bacterial species from many widely scattered books and special monographs, but the orderly arrangement of these descriptions, many of them imperfect and fragmentary, is a labor calculated to daunt any but Teutonic patience. That the task has been accomplished in such a satisfactory fashion by Professor Migula is matter for general congratulation.

There doubtless exist differences of opinion among bacteriologists as to how far systematists should carry out the process of welding together descriptions of species. There can be no question that many of the 'species' now masquerading under different titles are in reality identical and should be grouped under one name. On the other hand, it is equally true that forms now classed as 'varieties' are actually distinct and may be shown by future investigators to be widely separated. Two opposite tendencies are plainly visible among bacteriologists concerned in work of this character—and all bacteriologists are sooner or later brought face to face with the question of the 'identity' of the forms with which they are working: the tendency to magnify physiological differences and erect into new species or varieties those forms showing even slight divergence, and the tendency to ignore minor physiological characters and to include closely allied organisms under one species or group-name. Much more detailed study of the natural varieties of bacteria and of their plasticity under artificial conditions is necessary, however, before the true path can be surely determined.

The course pursued by Professor Migula in this matter is likely to command general approval. It will probably be more useful at the present stage of our knowledge to possess a convenient and accurate record of all descriptions by all writers than to have an elaborate tabulation that has been subjected to too much revision and consolidation. At the same time it may be questioned whether it is necessary or advisable to include in a work of the highest standard, descriptions glaringly imperfect and defective, so imperfect in fact that identification and evaluation are not now and never can be possible. The pages of the *System der Bakterien* might well be pruned of much dead and useless material of this nature.

The permanent value of a text of this sort can be thoroughly tested only by continual practical use, and it would be a work of supererogation to seek for the minor sins of omission and commission which any work dealing with bacterial classification must at present necessarily contain. One regrettable, but perhaps pardonable oversight only need be mentioned. The careful descriptions of a large number of water bacteria by two American bacteriologists, Wright (Memoirs National Academy of Sciences, VII., 1895) and Ravenel (Memoirs National Academy of Sciences, VIII., 1896) have evidently not come under the author's notice. Omissions of an important character are, however, surprisingly few and Professor Migula's great treatise will long remain the standard work in systematic bacteriology.

Edwin O. Jordan.

SCIENTIFIC JOURNALS AND ARTICLES.

Bird Lore for April opens with a description of 'A New Camera for Bird Photographers,' by the designer, John Rowley. 'Photographing a Robin' is described by A. L. Princehorn and 'How a Marsh Hawk Grows' is told by P. B. Peabody. In an article on 'The Egret Hunters of Venezuela,' George K. Cherrie shows the 'egret farms' of which we have heard are purely mythical and that the gathering of shed egret feathers is simply an incident in the work of the plume hunters. Marion E. Hubbard describes 'Bird Work at Wellesley College' and the balance of the number is given over to notes, correspondence, book reviews and reports of Audubon Department. The editor discusses the amendment to the law designed to protect non-game birds.

The Plant World for March begins with an amusing article on 'Popular Ignorance concerning Botany and Botanists,' by Aven Nelson T. H. Kearney discourses 'Concerning Saxifrages.' A. M. Curtiss tells of 'The Water Hyacinth in Florida.' A. Wetzstein of 'The Velvet Dogbane in Ohio,' and L. H. Pammel of 'The Twin-Leaf (*Jeffersonia diphylla*) in Iowa.' Under 'Plant Juices and their Commercial

Values,' Mrs. Caroline A. Creevy tells of tar, camphor, manna, opium and some perfumes. In the supplement devoted to the 'Families of Flowering Plants,' Charles Louis Pollard discusses the orders Pandanales, Helobiæ and Triuridales.

THE *Mathematical Gazette*, the organ of the English Mathematical Association, will in future be issued six, instead of three times a year. The *Gazette* will contain articles suggestive of improvements in methods of teaching, or covering ground not satisfactorily treated in text-books, reviews of mathematical books, together with shorter notices of new text-books, elementary mathematical notes, problems, and other matter of direct interest to mathematical teachers.

Erythea, the Italian botanical journal, will be discontinued at the close of the present volume.

SOCIETIES AND ACADEMIES.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

THE annual meeting was held on the evening of Monday, March 26th. Professor J. McK. Cattell was elected Chairman for the ensuing year. The Secretary of last year was continued in office.

Dr. A. L. Jones read a paper on 'The Symbolic Character of Geometrical Forms as a Principle of Explanation.' Among the attempts to explain formal beauty, that of Lipps in his 'Raumästhetik' is the most striking. He maintains that the æsthetical value of beautiful geometrical forms is due to the fact that they symbolize the activity of mechanical forces working themselves out freely; that we sympathize with the forces thus represented and receive pleasure when their action is unhindered; that the forces and laws of their action are not consciously recognized, but are merely *felt* or known unconsciously. His explanation involves some questionable metaphysics. The action of mechanical forces is no doubt an important element in many beautiful objects, but it remains to be proved that it is sufficient to explain all formal beauty in objects.

Dr. R. S. Woodworth presented a paper on 'The Fatigue of Voluntary Movement.' The fatigue of movement may be studied in reference to the loss in force, in accuracy, or in speed. In each of these respects experiments show that a movement may be continually repeated for hundreds and even thousands of times with only a comparatively slight loss of efficiency. The ergographic curve given by Mosso for force of movement is to be absolutely abandoned as a true picture of the curve of fatigue. This fact has been of late recognized in some able articles by Treves, working in Mosso's own laboratory; but it is best brought out by the use of Cattell's spring ergograph. One of the great causes of fatigue in force (and also in speed) of movement is the failure of the muscles to relax completely between successive contractions. If care is taken to secure this relaxation, 1000–1500 maximal ergographic contractions can be made with a loss of only 10 per cent. of the initial force. From the slowness of fatigue of various modes of voluntary movement, the inference follows that the fatigue of nerve centers is not rapid, as Mosso and Lombard have supposed, but slow in progress. This view is confirmed by tests of prolonged, hard and monotonous work of a mental kind. The quick and overmastering fatigue of common experience is not so much actual inability and loss of function as it is disinclination, resulting from disagreeable sensations and emotions and from impulses to change.

The third paper, given by Dr. Thorndike, was on 'Weber's Law in Judgments of Comparison with a Mental Standard.' This paper presented the results of some experiments on the accuracy of discriminations of weight, length and area, by subjects who judged by the aid of mental standards only. Within the limits chosen (40–120 gr., ½–12 ins., 20–60 sq. cm., and 2–12 sq. ins.) the accuracy of discrimination was found to decrease very slowly, very much more slowly than Weber's law or even the law of the combination of errors would allow. The theory proposed to account for this was that our judgments of amount or of difference are of complex origin, and may be made on various grounds. In so far as the ground is an accurate mental standard the sensations corresponding to large amounts may be associated with the proper judgment nearly or quite as readily as small amounts. In so far as the

ground is a combination of feelings or judgment, the inaccuracy of a judgment may vary, because of the combination of errors, as the square root of the amount. In so far as the ground is the mere mental shock of difference, the inaccuracy of the judgments may vary in some more direct relation to the amount.

CHARLES H. JUDD, *Secretary.*

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 321st meeting was held on Saturday, March 24th. Barton W. Evermann exhibited a series of proofs of the colored plates prepared to illustrate a forthcoming report on the fishes of Puerto Rico. Sylvester D. Judd described some 'Feeding Experiments with Captive Birds,' illustrating the difference between the methods of the Broad-winged Hawk and Shrike in killing and eating their prey. The habit of impaling its prey on thorns, employed by the Shrike, was considered to be due to the weakness of its legs which prevented the bird from holding and tearing its prey after the manner of the Hawk.

W. H. Osgood presented some 'Notes on a Trip Down the Yukon River' describing the character of the river in different portions of its course and the geological aspect of the banks. The various life regions through which it flowed were pointed out and their faunal and floral peculiarities were stated.

H. J. Webber discussed 'The Influence of Pollen on the Fruit of the Current Year,' describing two crucial experiments where the color and chemical constitution of corn had been changed as a result of the immediate influence of pollen or xenia. In one case sweet corn, which had been bred true to type for three generations, when crossed with yellow dent corn produced ears having smooth yellow dent kernels with starchy endosperm like the male parent. In the other case Hickory King, a white dent corn, with a large portion of corneous endosperm, grown from seed inbred the previous year and known to be pure, when crossed with Cuzco a plumbeous colored soft flour corn produced kernels of plumbeous color or with plumbeous colored spots and little corneous endosperm in these characters resembling the male parent.

F. A. Lucas spoke of 'The Tusks of the Mammoth' saying while the animal was usually represented with the tips of the tusks flaring outward there was good reason to believe that the tusks pointed inward at the tips as in the modern elephants. He illustrated his remarks with photographs of different specimens including one 12 feet 10 inches long, from Alaska believed to be the longest tusk on record.

F. A. LUCAS.

GEOLOGICAL SOCIETY OF WASHINGTON.

THE 100th regular meeting was held at the Cosmos Club, March 28, 1900.

The program for the evening comprised a 'Symposium on Field Methods,' illustrated by notebooks, maps and instruments used in each class of work. The following contributions were presented:

M. R. Campbell and A. Keith—Appalachian Methods.

T. W. Vaughan—Great Plains Methods.

G. O. Smith—Lake Superior Methods.

J. D. Irving—Adirondack Methods.

J. E. Spurr—Reconnaissance Methods in the Great Basin.

A. H. Brooks—Reconnaissance Methods in Alaska.

W. Cross—Rocky Mountain Methods.

H. W. Turner—Sierra Nevada Methods.

F. L. RANSOME,
DAVID WHITE,
Secretaries.

DISCUSSION AND CORRESPONDENCE.

'NEW-DARWINISM.'

TO THE EDITOR OF SCIENCE: In a review of my book 'Darwinism and Lamarckism' (G. P. Putnam's Sons) in SCIENCE for December 29, 1899, Mr. C. W. Hargitt objects, perhaps rightly, to my using the term 'New-Darwinism,' in a sense different from that in which it has been used by many biologists. I quite agree with him that I ought to have given my reasons for thus using the term and I shall feel obliged if you will allow me to give those reasons now.

About ten years ago Dr. A. R. Wallace published a book on the theory of Natural Selection, and about the same time Professor Weismann published an essay on heredity. Both advo-

cated natural selection as the sole cause of organic evolution and pronounced the inheritance of acquired characters to be impossible. Mr. Wallace called his book 'Darwinism.' In time these opinions were called the 'New Darwinism,' although some of them were quite at variance with those always held by Darwin up to his death.

A little later Dr. Romanes' book called 'After Darwinism' appeared, in which he amplified the views held by Darwin in a way to which, I think, Darwin himself would have agreed. This also has been called by some the 'New-Darwinism' with, as I think, a much better right to the title than those advocated in Wallace's book, which should have been called Wallaceism. I object to Mr. H. Spencer and others using the term New-Darwinism for Wallace's opinions; for, when it is shown that these are wrong, the unscientific public will naturally conclude that Darwin was also wrong, although he would himself have repudiated this New-Darwinism.

F. W. HUTTON.

CANTERBURY MUSEUM,
CHRIST CHURCH, NEW ZEALAND,
February, 21, 1900.

'THE ESKIMO OF SMITH SOUND.'

TO THE EDITOR OF SCIENCE: The attention of the readers of SCIENCE is specially invited to a pamphlet of sixty pages, published by the American Museum of Natural History, entitled 'The Eskimo of Smith Sound,' by A. L. Kroeber. The Smith Sound Eskimo stand ethnologically between those of Greenland and the Central Eskimo and form a transition from the latter to the former. The theory of Holm that the Angmagsalingmiut (East Greenlanders) reached their present abode by following the ice-bound shores of Northern Greenland, is held to be untenable. Again, in examining Kroeber's illustrations, the opinion long ago published by this writer that no unsophisticated Eskimo ever etched on bone, ivory or antler is sustained. The small amount of engraving present is evidently the work of steel tools.

But, most interesting of all the accounts in the pamphlet is that concerning the loss and recovery of the kaiak. These Smith Sound Eskimo were discovered by Sir John Ross, in 1818, and were afterwards visited by Franklin, Kane, Hayes, Hall and others. Now, none of the explorers saw kaiaks in the sound. The art of building them had apparently been forgotten, though the word 'kaiak' remained in the language. From the time of Ross abundance of material for the structure was at hand, the environment was there begging for kaiaks, but the culture-hero had to come and teach them their own lost art. Between 1868 and Peary's visit the Adlet (Ellesmere Land Eskimo) had furnished the culture-hero and now the fisherman recovers his skill. The arts of the Smith Sound Eskimo are clearly set forth and compared with the Central tribes of Boas, and the traditions given at length.

O. T. MASON.

A CHRONOLOGICAL INDEX.

TO THE EDITOR OF SCIENCE:—Every scientific writer who has read with open mind the entreaties of recent writers on the subject has already adopted the plan of giving the year (as well as the volume) of any journal to which he has occasion to refer; few people wish to look up the reference (only those who are about to write on the subject), but every one who reads the article at all is interested in knowing the date of the contribution to the subject referred to—often, in fact, the reference wholly loses its point from a lack of this knowledge. Since, moreover, there are still many scientific writers who do not belong to the above described category, I wish to suggest that it would be a work of very great value if some one would issue a finding list, covering several hundreds of the principal scientific journals, which would enable the reader to pass at a glance from volume to year. Such a list would involve very little trouble on the part of whoever would be so good as to make it up, and it would certainly be a very great convenience. It might be printed on separate cards for separate subjects, and the scientific reader could have these cards (or as many of them as interested him) always at his elbow.

If both year and volume cannot be given when articles are referred to (for economy of space—there can be no other reason), it seems

plain that the year is by far the more important of the two. The only inconvenience that could arise from not knowing the volume would be that in the case of those journals in which the volume does not begin with the year it might sometimes be necessary to take down from the shelf two books instead of one before the right place is found—an inconvenience of the very slightest kind. Of course every really virtuous scientific writer now gives his full references at the end of his paper, with year and volume both, and refers to them in the body of his paper thus — Déjerine-Klumpke, '94, III.— when the reference is to the third paper issued by Déjerine-Klumpke in the year 1894. Pending the attainment of perfect virtue on the part of writers (and also for the convenient reading of all articles of the past), I submit that a table of cross-references, such as I have described, would be a work deserving of heartfelt gratitude on the part of an overworked scientific world.

C. L. F.

[A chronological table giving the year in which each volume of 550 scientific journals was published is included in the 'Catalogue of Scientific and Technical Periodicals,' by Dr. H. Carrington Bolton, the second edition of which was published by the Smithsonian Institution in 1897.—Ed. Science.]

THE INTERNATIONAL CONGRESS OF MECHANICS.

To the Editor of Science: M. Marcel Delmas, 10 Boulevard Emile Augier, Paris-Passy, has charge of the report of the 'Congress de Mecanique de l'Exposition universelle,' in the department of applications of electricity to the various apparatus of haulage, hoisting, etc. (including cranes, elevators, winches, swing-bridges, pumps and other such mechanisms), and particularly desires information regarding the economic side of the matter. He requests that all, whether intending exhibitors or others, who are willing to assist in the collection of this data, send him, at the address given above, statements of costs of installations, of exploitation and incidental expenses, especially where a comparison can be made with costs of the older systems under similar circumstances. All publications and illustrations will be welcome, if authentic and exact in statement of facts and data.

R. H. Thurston.

NOTES ON PHYSICS.

LIQUID AIR.

C. Linde gives some interesting data on liquid air in the *Physikalische Zeitschrift* for January 6, 1900. He calls attention to the fact that the commercial use of liquid air depends in the first place upon the amount of energy consumed in its production and upon the length of time that the liquid can be kept before it is used. With small machines from 3 to 4 horsepower—hours are used per kilogram of liquid air, while the largest machine hitherto built, produces fifty kilograms of liquid air per hour and consumes about 100 H. P. This latter corresponds to an efficiency of 15% as compared with what a perfect thermodynamic machine would accomplish.

Small quantities (about one liter) of liquid air in vacuum jacketed and silvered vessels are lost by evaporation in about 14 days. In large tin vessels (50 liters) covered with hair felt about two liters per hour is lost by vaporization. The author gives data concerning the use of liquid air for refrigeration and for power. When extremely low temperatures are desired liquid air is perhaps the best possible means for producing it. On the other hand from twenty to forty times as much energy is consumed in producing moderate refrigeration by liquid air than is required in the ordinary ammonia refrigerator. Thus a kilogram of liquid air evaporated in a room reduces the temperature of the room only about as much as the melting of two kilograms of ice, and two kilograms of ice may be produced by the evaporation of 1/20 horse-power-hour or less.

When liquid air as evaporated at ordinary temperatures and used to drive a motor, the work developed by the motor is only about three or four per cent. of the energy consumed in the production of the liquid air. The author however points out special cases where the use of liquid air for power might be desirable.

The author mentions some experiments which have been made in the Simplon tunnel, now building, to test the usefulness of a mixture of liquid air or liquid oxygen and mineral oil

(soaked up in powdered charcoal) as an explosive. These experiments have not fully determined the usefulness of this cheap explosive, the principal difficulty being that the mixture changes its composition rapidly as the nitrogen and oxygen evaporate.

The author suggests that the most promising field for liquid air machines is in their use for separating (partially) the oxygen from the large amount of nitrogen with which it is associated in the atmosphere.

ATMOSPHERIC ELECTRICITY.

AT last we have a reasonable theory of atmospheric electricity based upon facts. Elster and Geitel, and independently J. J. Thomson and C. T. R. Wilson, have applied the known properties of ionized gases to the explanation of atmospheric electricity. The sun's light, especially the ultra violet rays, ionizes the atmosphere producing equal numbers of positively and negatively charged ions. These ions are ordinarily present in equal numbers in dry air and their charges do not therefore develop any perceptible electric potential. When the air is cooled below its dew point, however, the negative ions mainly serve as nuclei upon which the moisture is condensed in drops which in falling remove the negative ions, leave an excess of positive ions; this excess of positive ions gives rise to very great electric potentials, and produces the electrical effects which accompany rain. The reasonableness of this theory is that every physical action which enters into it has been followed in the laboratory—the ionization of air by ultra violet light, the condensation of moisture on the negative ions, etc.

W. S. F.

CURRENT NOTES ON PHYSIOGRAPHY.

GLACIAL LAKES IN WESTERN NEW YORK.

FAIRCHILD has extended his studies of glacial lakes to the Finger lake district of western New York, and presents a comprehensive sketch of nineteen valleys in which such lakes were formed, several of them showing shore lines at successive levels (*Bull. Geol. Soc. Amer.*, X., 1899, 27–68). The southward overflows of the lakes, leading over passes between the hills of the Allegheny plateau to the different headwater streams of the Allegheny and Susquehanna rivers, are enumerated and figured. The eastward outlets, between the northern slope of the plateau and the retreating front of the ice, previously described by Gilbert and Quereau, are here beautifully illustrated; they prove to be even stronger topographic features than the channels of similar origin carved in the drift of eastern Michigan, as described by Taylor.

Reference should be made in this connection to a thesis on 'Some higher levels in the post-glacial development of the Finger lakes of New York State,' submitted by T. L. Watson, a graduate student in Cornell University in 1897 (Rept. Director N. Y. State Museum, 1898, App. B, 65–117).

THE POMMERANIAN COAST-LAND.

DETAILS concerning the course of valleys formed by rivers marginal to the retreating ice of north Germany recently given by Keilhack (Die Stillstandslagen des letzten Indlandeises und die hydrographische Entwickelung des pommerschen Küstengebietes, Jahrb. k. preuss. geol. Landesanstalt, 1899, 90–152, 14 maps) supplement the general account referred to in SCIENCE for January 5, 1900. After the ice sheet had withdrawn from the morainic hills of the Pommeranian lake belt, twelve successive stages of constrained drainage are recognized and mapped, interrupted terminal moraines having been formed during some of the stages, and special conditions of marginal drainage having characterized every one of them. The important valleys eroded in the uplands by rivers marginal to the retreating ice are analogous to those above described, in the northern spurs of the Allegheny plateau of west central New York. If any one desires novel evidence of the former existence of land ice-sheets, and of their importance in fashioning, directly, or indirectly, existing geographical features, it may be found in abundance in the two districts here referred to.

GERMAN PHYSIOGRAPHIC TERMS.

A CHAPTER on the Earth's Surface, written by Penck for Scobel's 'Geographisches Handbuch zu Andrees Handatlas' (3d ed., 1899), presents

a compact epitome of the physiography of the lands, in which the German equivalents for a number of English terms may be found. The cycle of denudation (Umbildungscyklus) opens with initial forms (Urformen) produced in the large way by deformation (Grossformen, Strukturformen), such as masses of vertical movement (Schollenländer) with raised blocks and rift valleys (Horste, Graben), or folded zones (Stauungszone) with arches and troughs (Rücken, Thalungen). Destructive agencies carve the details (Kleinformen, Skulpturformen) of consequent and subsequent features (Folgeformen, Unterfolgeformen) such as are seen in regions of young and mature valleys (jugendliche, ausgereifte Thallandschaften). The diversion (Ablenkung) of one stream by another causes a migration of divides (Wanderung der Wasserscheiden) and results in an adjustment (Anpassung) of streams to structures; initial, consequent, and subsequent divides (Ur-, Folge-, Unterfolgescheiden) may therefore be recognized. As the valleys widen and consume the hills, old age (Alter der Landschaflen) is reached, ending in a peneplain (Rumpflandschaft). It is possible to combine cycles of different stages (Stadien), the sequential forms (Skulpturformen) of the first cycle having served as the initial forms (Urformen) of the next. Some of Penck's terms, such as Schichtstufen, Schichtkammlandschaft, Durchbruchthal, have no simple equivalents in English.

LAKES OF THE BÖHMERWALD.

Eight small lakes occupy corrie-basins in the Böhmerwald. Their physical features are described and their origin is discussed by P. Wagner (Die Seen des Böhmerwaldes, Wiss. Veröffentlichungen, Verein f. Erdkunde, Leipzig, iv., 1899, 1–90, maps, sections and views). After a general consideration of the various theories as to the origin of corries (Karen, Cirques, Botner) through erosion by water, obstruction by rockfalls, and excavation by névé and ice, the author concludes that the best developed corries, with background of cliffs and rounded basin of clean-scoured rock, are valleys of preglacial erosion modified by snow and ice action during the glacial period.

W. M. Davis.

CURRENT NOTES ON METEOROLOGY.

DEATH OF MR. G. J. SYMONS.

Mr. George James Symons, who died in London on March 10th, was well known throughout the meteorological world as the founder and head of the British Rainfall Service. In 1857 he started an organization for observing and recording thunderstorms, and soon afterwards began his life work on British Rainfall, which he continued till his death. The observers co-operating in this undertaking now number between 3000 and 4000, and the results of the observations have been published annually in successive volumes, bearing the title *British Rainfall*. The first volume contained the records for the year 1860, and the fortieth is shortly to be issued. Mr. Symons occupied a unique position, that of a private individual in charge of a great meteorological service, which he himself built up and administered. In 1866 Mr. Symons began the publication of his *Monthly Meteorological Magazine*, to which reference has from time to time been made in these Notes. His name is further well known in connection with the meteorological section of the Royal Society's Report on the Krakatoa eruption, and with his valuable contributions to meteorological bibliography. He rendered important assistance in the preparation of the *Bibliography of Meteorology*, published by the U. S. Signal Service. Mr. Symons was a Fellow of the Royal Society, a member of the General Committee of the British Association, President of the Royal Meteorological Society, and for 27 years the Honorary Secretary of that Society. He was created a Chevalier of the Legion d'Honneur in 1891, and was selected by the Prince of Wales to receive the Albert Medal of the Society of Arts for 1897, "for services he rendered to the United Kingdom by affording to engineers engaged in the water supply and sewerage of towns a trustworthy basis for their work by establishing and carrying on during nearly 40 years systematic observations (now at over 3000 stations) of the rainfall of the British Isles, and by recording, tabulating, and graphically indicating the results of these observations in the annual volumes published by himself." Meteorology can ill afford to lose so unselfish a worker as Mr. George J. Symons.

THE MISTRAL.

THE *mistral* is well known as a strong cold wind which is common in the region about Marseilles, in southern France. It occurs when there is a barometric gradient to the south from the plateau of Central France, the cold air flowing quickly down the gradient and producing what the Germans have well named a *Fall-wind*. In the districts which are subject to frequent mistrals, the trees are bent to the southeast under the influence of the strong northwest wind, and the gardens are protected by means of high walls. The mistral is often so violent as to cause considerable damage, and sometimes even loss of life. Kassner, in *Das Wetter* for February, mentions the case of a mistral which occurred on January 20th, of this year. A carriage in which a lady was driving was blown into a canal, and the passenger and horse were drowned. One man was severely cut in the head by a tile which was blown from a roof, and another was thrown down by the wind and badly hurt. In view of the accident to the carriage above referred to, the mayor of Marseilles issued an order to the effect that hereafter no carriages are to be allowed to drive along the canals or the water-front while a mistral is blowing. Ordinary street traffic in Marseilles is always considerably interfered with by a violent or a long-continued mistral.

TYPHOONS OF THE PHILIPPINE ISLANDS.

THE Manila Observatory, under the direction of the Jesuit Fathers, has been keeping on with its excellent meteorological work throughout the troublous times of the past two years or more. The latest publication which has come to hand from the Observatory is a report by Father Doyle, entitled, *Tifones del Archipielago Filipino y Mares circunvecinos 1895 y 1896*. This is a valuable extension of the work already done by the Manila Observatory in connection with the typhoons, or *baguios*, of the Philippine region, and is a fitting supplement to Father Algué's report, *Baguios ó Ciclones Filipinos*, dated 1897. The present report gives a detailed account of the different typhoons, with tabulated meteorological observations relating to them. The tracks are plotted on a series of eight maps, and the fluctuations in atmospheric pressure noted during the passage of three special typhoons are represented graphically.

CLIMATE AND MILITARY OPERATIONS.

The Influence of Climate on Military Operations is the title of a chapter in a recent work on *Outlines of Military Geography*, by T. M. Maguire (Cambridge, Eng., 1899, Cambridge Geographical Series). Dwellers on plains are compared with dwellers in mountainous regions; the severity of the seasons is noted in connection with Napoleon's Russian expedition and other military campaigns, and the subject of disease among troops is also touched upon.

R. DEC. WARD.

HARVARD UNIVERSITY.

PATENTS AND THE INDUSTRIES.

THE recently published report of the U. S. Commissioner of Patents is a reminder of the facts that this system of protection of the inventor and of assurance to him of the product of his brain, a system to which those familiar with the subject attribute a large share of our unexampled progress in the arts and industries, has, of late years, received far less consideration than formerly and that it has not been cared for as it should be. It is the most remarkable stimulant to invention that the world has yet seen, and to it the country owes more than can be either estimated or compensated. Yet apparently neither the committees to which its interests are entrusted, nor the Congress itself gives much consideration to its needs or its deserts. Nearly 50,000 applications for patents on new inventions have been recorded in a single year. The receipts of the office were last year far above its expenditures—$1,325,457 and $1,211,783—and this has been the fact in every year of its century of existence, with the exception of but eight. In 1883, the surplus for the year amounted to about a half million dollars. The total balance of the Patent Office to-day amounts to $5,086,649; but Congress does not even permit this earned capital to be appropriated to the needs of the Patent Office. It has a wealth of resources and is annually adding to them; yet it is permitted to need additions to its staff of examiners, to suffer for lack of additions to its library, which should be the

finest technical library in the world, to need larger and better quarters for its work, and it is even crowded in its own building by squatting bureaus of the Treasury Department Land Office.

The report on the number of patents issued in 1899 gives the number from New York as 3798; Pennsylvania, 2355; Illinois, 2152; Massachusetts, 1774; Ohio, 1501. Connecticut, however, as famous as ever in this direction, leads the list in inventiveness, securing one patent to each 945 inhabitants; the District of Columbia, curiously enough, but probably by a legal fiction, follows with 1 to every 1151, Massachusetts with 1 to each 1261 people, Rhode Island with 1 to 1270, New York coming in as number eight, with 1 to 1579. South Carolina ends the list with 1 to 25,024 people and North Carolina is next with 1 to 21,012. New England, as always, stands in the van, for the United States and the world, in inventiveness.

Of other countries, Great Britain leads, Germany stands next, and France is third in the list of foreign patentees in the United States Patent Office.

In performing their work of research, to solve the question of originality on the part of the inventor, the examiners have to seek among 700,000 earlier United States patents, 1,250,000 foreign patents and 74,000 published volumes of inventions and scientific and industrial treatises. But, as the Commissioner states, "The lack of suitable room greatly hampers and unnecessarily delays the work in many divisions."

This is now the regular and invariable general formula of the report of the United States Patent Office. It has been thus for many years past; exhibiting an enormous amount of work, performed under most unfavorable conditions; giving our country the leading position in invention, and in many industries; promoting the wealth of the nation enormously; earning an annual surplus; yet refused the use of its own earnings even to provide imperatively needed space and equipment, and forbidden even to add to its own library, its most essential tool, or to dispose of duplicate and useless books in exchange for others more needed.

Through the efforts and the genius of our inventors, the cost of products in every department of industry has been reduced to a fraction of the figures of a generation ago; the work of one man had been made more effective than was then the work of, in some cases, a dozen, and the wealth of the country is, by these means, being augmented, and all its attendant comforts and privileges increased to the average citizen, at the rate of one hundred per cent. in a generation. Yet the inventor is ungratefully neglected, and Congress devotes itself to 'politics' rather than statecraft.

Many organizations, and hundreds of individual citizens, made aware of these discreditable facts, are urging upon members of Congress to give proper attention to the Patent Office; but it apparently will require more pressure than the American Society of Mechanical Engineers, and all the other national associations seeking to promote this reform, can exert to insure attention to a primary duty. Every citizen has an interest in this matter, and should do what he can to bring about a reform in Congress, and the provision for the Patent Office of every need and convenience.

R. H. Thurston.

BRINTON MEMORIAL CHAIR IN THE UNIVERSITY OF PENNSYLVANIA.

Scholars the world over are appreciative of the achievements of the late Daniel Garrison Brinton for he established on a firm basis the branches of learning to which he devoted his life. He is justly named the 'Founder of American Anthropology.'

A close student of the intricate problems of his science, he possessed the rare art of clearly and concisely presenting facts at their true values. He believed in 'The general inculcation of the love of truth, scientific, verifiable truth' and that knowlege should subserve usefulness.

A keen observer, a classical scholar, an adept in the methods of logic and philosophy, Dr. Brinton had ever the practical application of truth in view. To the systematic study of man he brought to bear his all rounded culture to further the happiness and fullness of the individual life. He regarded the individual as the starting point and goal of anthropology. Upon

individual improvement, he claimed, depended group or racial improvement, social amelioration, and the welfare of humanity.

Anthropology, the New Science of Man, in Dr. Brinton's own words "is the study of the whole of man, his psychical as well as his physical nature, and the products of all his activities, whether in the past or the present."

This broad comprehension indicates the significance of anthropological study. Its limits of attainment are limited only by the nature of man himself, and Dr. Brinton asks "who dares set a limit to that?"

Although the youngest of the modern sciences anthropology is none the less one of the most important of the sciences, for in its development is bound closely the progress of society. To carry out the aims of anthropology are required the results obtained from the study of ethnography, ethnology, psychology, folk-lore and archæology—more especially pre-historic archæology which concerns itself not only with the ancient but with 'the simplest' and 'most transparent and therefore the most instructive.'

Notwithstanding the extension of this work in America, comparatively few professorships of anthropology or its branches exist, and the limited opportunity afforded students to qualify themselves for investigation in these various subjects is manifest. Dr. Brinton pointed out the insufficiency of facilities for students to acquire the necessary preliminary training to fit them for research, and he advocated and urged that anthropology should be studied generally in our colleges. Provost Harrison referred to this in his address at the Brinton Memorial Meeting held in Philadelphia in January last, and stated that Dr. Brinton had the utmost confidence in anthropology as a science and also in its practical worth as an applied science in politics, education and legislation.

It is proposed in recognition of the great services he rendered to the world by his teachings, numerous publications, and untiring zeal in unearthing the false and proclaiming the true, to establish in his memory a Brinton Chair of American Archæology and Ethnology in the University of Pennsylvania.

This proposition has received the universal commendation and approval of anthropological scholars both in Europe and America.

At the Memorial Meeting the plan was favorably mentioned and grateful recognition accorded to Dr. Brinton's unselfish devotion to his chosen life work. Provost Harrison thought that to honor his memory no more worthy tribute could be given than the foundation of a Brinton Memorial Chair in the University of Pennsylvania. Professor Putnam, following these remarks, said that he trusted the suggestion would not be dropped but that something tangible would come from Provost Harrison's words.

The choice of this place for the seat of the Brinton Memorial seems especially appropriate since the University of Pennsylvania now possesses Dr. Brinton's valuable library, his own gift shortly before his death. The association of Brinton's name with the University from 1886, when the chair of American Anthropology and Linguistics was created for his occupancy, may in this way be made permanent.

In order to accomplish the proposed plan, it will be necessary to secure an endowment of fifty thousand dollars from individual sources. Patrons of science and others interested in the endowment may apply to the Brinton Memorial Committee, 44 Mount Vernon Street, Boston, Mass., where further information is to be obtained if desired.

Messrs. Drexel & Co., bankers, Philadelphia, have kindly consented to act as Treasurers on certain conditions which will be explained to contributors on application to the Brinton Memorial Committee.

SCIENTIFIC NOTES AND NEWS.

THE annual stated meeting of the National Academy of Sciences will be held next week beginning on Tuesday, April 17th.

AT the annual meeting of the Astronomical Society of the Pacific, held in San Francisco, on March 31st, the Bruce Gold Medal of the Society was awarded to Dr. David Gill, H.M. astronomer, at the Cape of Good Hope. This is the third award of this medal.

DR. ALEXANDER AGASSIZ has returned to the United States from his expedition to the

South Sea Islands. The *Albatross* is still at Yokohama.

Major J. W. Powell, director of the Bureau of American Ethnology, and Professor W. H. Holmes, head curator of the U. S. National Museum, have just returned from an archæologic tour through Cuba and Jamaica. They succeeded in obtaining important data relating to lines of culture migration in this region, and especially to the connection between the Caribs of the South American continent and the aboriginal tribes of the West Indies and Florida.

Dr. J. Walter Fewkes, of the Bureau of American Ethnology, has just completed a successful season's work among the Hopi Indians. He has observed all the winter ceremonies of the tribe, a part of which have never before been studied, and his notes are accompanied by full series of photographs, diagrams, etc., as well as collateral records bearing on the general ethnology of the tribe.

The board of directors of the Astronomical Society of the Pacific have elected Dr. J. E. Keeler, director of the Lick Observatory, to be president of the Society, and Mr. Chas. Burckhalter of the Chabot Observatory, to be first vice-president for the ensuing year.

M. Drake del Castillo has been elected president of the Botanical Society of France.

At the next convocation of McGill University, Montreal, Mr. J. F. Whiteaves, F.G.S., paleontologist and zoologist to the geological survey of Canada, is to have the degree of LL.D. conferred on him by that University *honoris causa*.

At the same convocation, Mr. A. G. Barlow, M.A., of the same survey, will receive the degree of Doctor of Science *in course*. His researches in the Archæan of Canada have placed Mr. Barlow in the foremost ranks of North American geologists. A synopsis of his latest report on the geology and resources of the Lake Temiskaming and Lake Nipissing country of Canada appeared in a recent issue of Science.

Aleksandr O. Kovalevskij, St. Petersburg; J. A. Gaudry, Paris; P. G. Tait, Edinburgh; J. H. van't Hoff, Berlin and J. J. Thomson, Cambridge, have been elected members of the Royal Irish Academy.

Dr. B. M. Duggar, of Cornell University, has been appointed by the authorities of the Smithsonian Institution to the table for research, which that institution supports at the Statione Zoologica, Naples, Italy. He has already entered upon his work there.

Frank Hamilton Cushing, ethnologist in the Bureau of American Ethnology, died on April 10th, at the age of forty-three years.

The death is announced of M. Joseph Bertrand, professor of physics in the Collège de France and permanent secretary of the Paris Academy of Sciences.

Dr. E. J. Lowe, F.R.S., known for his important contributions to meteorology and natural science, died at Chepstow, on March 10th, aged 75 years.

We also note with regret the following deaths among German men of science: Dr. G. Karsten, professor of physics at the University of Kiel, aged 79 years; Dr. Elwin Bruno Cristoffel, late professor of mathematics at the University of Strassburg, aged 70 years, and Professor Teichmann, professor of mechanical engineering at the Technical Institute at Stuttgart, aged 61 years.

The British Association for the Advancement of Science will hold its seventieth annual meeting at Bradford, beginning Wednesday, September 5th. Sir William Turner, F.R.S., will preside, and the presidents of the sections will be as follows: Mathematical and physical science, Dr. J. Larmor, F.R.S.; chemistry, Professor W. H. Perkin, F.R.S.; geology, Professor W. G. Sollas, F.R.S.; zoology (and physiology), Dr. R. H. Traquair, F.R.S.; geography, Sir George S. Robertson; economic science and statistics, Major P. G. Craigie; mechanical science, Sir Alexander R. Binnie; anthropology, Professor John Rhys; botany, Professor Sydney H. Vines, F.R.S. The two evening discourses will be delivered by Professor Francis Gotch, F.R.S., on 'Animal Electricity,' and Professor W. Stroud, on 'Range Finders.'

The American Physiological Society will hold its fifth special meeting in Washington on Tuesday, Wednesday and Thursday, May 1, 2 and

3, 1900, as one of constituent societies of the Fifth Congress of American Physicians and Surgeons. The usual smoker will be held on Monday evening, April 30th. The headquarters of the Society will be at the Hotel Wellington.

THE annual general meeting of Chemical Society, London, was held on March 20th. At this meeting the Longstaff Medal was presented to Professor W. H. Perken, Junr., F.R.S. In the evening the Bunsen Memorial Lecture was delivered by Sir Henry E. Roscoe, F.R.S.

W J MCGEE, ethnologist-in-charge, Bureau of American Ethnology, has just completed a course of three lectures on modern anthropology at Howard University, Washington. The special topics and dates were (1) 'The Stages of Culture,' March 15th; (2) 'The Rise of Civilization,' March 22d; and (3) 'The Dawn of Enlightenment,' March 29th.

DR. EDWARD CAIRD, master of Balliol College, Oxford, who was formerly professor of moral philosophy at Glasgow University, has been nominated as Gifford lecturer in the latter university, in succession to Sir Michael Foster, M.P.

UNDER authority from the Director of the Marine Biological Laboratory, Dr. C. O. Whitman, the Association for Maintaining the American Women's Table at the Zoological Station at Naples, offers for the summer of 1900 the free use of an investigator's table at the Laboratory at Woods Holl to any well qualified applicant who may desire to secure the benefit of preliminary training at Woods Holl, before applying for the American Women's Table at Naples. Applications for the Woods Holl Table should be made before May 1st, to the Secretary of the American Women's Table at Naples, Miss Florence M. Cushing, No. 8 Walnut street, Boston, Mass.

THE *Ninth Annual Report* of the British Society for the Protection of Birds, which now has a membership of 22,000, shows that its work extends effectively even to China, India and New Guinea. In the *résumé* of the year's work we learn that the wearing of osprey (egret) plumes has been discontinued by the officers of the Hussar and Rifle Regiments and of the Royal Horse Artillery, and also by the Viceroy's Bodyguard, of India.

WE noticed the destruction of the observatory at Tananarivo, Madagascar, in 1895 as a result of the French campaign. Dr. Tiessen's bureau reports that the French Government of the colony has appropriated 10,000 fr. for repairs which are being carried on under the director, M. Collin.

THE Pasteur Institute, Paris, has received 100,000 fr. by the will of the late M. Crevat-Durand.

PROFESSOR E. A. SCHÄFFER has been given a grant of £100 from the Earl of Morray endowment fund for physiological research.

MR. WILLIAM M. JOHNSON has offered to give the town of Hackensack, N. J., a plot of ground and a library building to cost from $30,000 to $40,000 on condition that the library be supported by the town.

Nature states that the Lemaire scientific expedition has reached Tenka, after a successful and peaceful journey of 3000 kilometres along the border of the Congo State. Three days east of Lualaba Mission the expedition met Major Gibbons, who was on his way to Tanganyika, *via* Lafoi, and thence to the Nile.

TWO of the largest recorded tusks of the African elephant have recently been brought to New York from Zanzibar, and Mr. Kaldenberg, the well known dealer in ivory, states that the accounts recently published in the daily papers concerning them are substantially correct. One tusk weighs 225 pounds the other 239 pounds, weights that will probably exceed those of any tusks of the mammoth, if not indeed those of any species of elephant yet noted.

THE committee on Public Lands of the House of Representatives in Congress is considering the bill prepared on behalf of the Committees of the American Association for the Advancement of Science and the Archæological Institute of America for the preservation of prehistoric monuments, ruins, etc., etc., on the public domain, by reserving the lands on which they stand from entry and sale. The bill has been referred to, and is now in the hands of a sub-committee consisting of Messrs. Shafroth of

Colorado, Moody of Oregon, and Jones of Washington. The members of the two societies, and citizens interested with them, may materially assist in securing some affirmative action if they will signify their desire in person or by letter to any Member of Congress with whom they may be acquainted.

THE appropriation bill for the U. S. Agricultural Department, reported to the House, April 7th, carries $4,116,400, being $390,778 more than was allowed for the current year. Two additional scientific appointments (one biologist and one botanist) have been allowed. An additional allowance of $40,000 for seed distribution is granted upon the petition of 225 members of the House; $60,000 is appropriated for iron warning towers for the weather bureau in place of the present wooden structures; $38,000 for an animal quarantine station at New York; $47,000 additional for meat inspection and $200,000 for a laboratory building on the grounds of the Agricultural Department in Washington. This building is for the laboratories necessary to carry on the work of the scientific divisions of the department which are now occupying rented quarters. The bill has been placed on the calendar of the House, and will be called up some time next week.

THE House Committee on Appropriations has received an estimate from the Secretary of the Treasury of an appropriation of $15,000 for expenses of procuring and transporting to the National Zoological Park, Washington, D. C., specimens of the indigenous animals of Alaska, and of constructing the necessary paddocks and houses.

THE Council of the province of Brabant in Belgium has decided to establish an Institute of Bacteriology. About $30,000 will be spent on the building and about $9000 annually for maintenance.

A COLONIAL institute is to be opened in Marseilles to prepare young men to fill positions in the French colonies. Expeditions of students will be sent out at the expense of the State, and commercial houses will receive the information thus obtained in the form of detailed reports. Instruction will be given in botany, zoology, natural history, colonial geography and history, etc. There will be a museum of plants, minerals, etc., so that the student may become acquainted with the actual products of the colonies; also, a school of medicine to familiarize him with diseases peculiar to tropical countries. It is probable that arrangements will be made for teaching oriental languages. For grounds and building, the city of Marseilles has donated $193,000.

CONSUL GENERAL GUENTHER, of Frankfort, writes to the Department of State that the negotiations between the city of Hamburg and the Imperial German Foreign Office for the establishment of a tropical hygienic institute at Hamburg have been completed. According to agreement, an institute for ship and tropical diseases is to be opened on October 1st. Its purpose is to investigate these diseases, to serve as a preparatory school for physicians to go to German colonies in tropical climates, and for the study of hygienic questions. The head physician and his scientific assistants will be selected at Hamburg with the consent of the colonial department of the Foreign Office. The general government will contribute to its support, while the city of Hamburg will have to furnish at all times as many beds as the colonial department may require. Dangerously contagious diseases, as pest, cholera, and smallpox, will not be treated in the institute. The Senate of Hamburg has submitted the project to the city for approval and has also recommended an appropriation of about $31,500 for remodeling the hospital for sailors.

THE London *Times* gives the following details in regards to the late Dr. William Marcet, whose death we were recently compelled to record. He was the eldest son of Professor Francis Marcet, of Geneva, and grandson of Dr. Alexander Marcet, of Guy's Hospital, and Jane Marcet, the authoress. He was born and educated in Geneva. At the age of 18 he commenced the study of medicine at the University of Edinburgh, where he was the champion and friend of Murchison, Burdon Sanderson, William Priestley, and others since distinguished in medicine and science. After graduating with honors, in 1850, Dr. Marcet came to London and devoted himself to the practice of his

profession and to scientific work. For his researches in physiological chemistry he was elected a Fellow of the Royal Society at an early age. He was also one of the first workers in the field of laryngology. During his residence in London he held the offices of assistant physician to the Westminster Hospital and to the Brompton Hospital for Consumption. During the latter part of his life Dr. Marcet devoted himself almost entirely to scientific work. His ardent love of mountains and mountaineering to a large extent determined the direction of his later work. An inquiry into the influence of altitude on respiration, which he carried out with characteristic vigor and thoroughness both on the high Alps and on the peak of Teneriffe, led the way to an extended series of valuable observations and experiments on the phenomena of respiration in man. These formed the subjects of several important contributions to the Philosophical Transactions and inspired his Croonian lectures delivered before the College of Physicians in 1895. Dr. Marcet was also a well known worker in the field of meteorology and climatology and was the author of an excellent treatise on Southern and Swiss health resorts. He was elected President of the Royal Meteorological Society in 1888. In 1865 Dr. Marcet was requested by the members of the Royal Commission for the Investigation of the Cattle Plague to undertake to investigate the chemical pathology of the disease, and his report on the subject appeared as an appendix to the third report of this Commissioners. The late Sir Thomas Watson remarked of the report of this Commission "that probably no disease either of man or of animals has ever undergone such an investigation in all its details as has the cattle plague." In 1859 he was elected a Fellow of the Royal College of Physicians, appointed examiner in chemistry in 1867, and subsequently served the office of councillor.

THE Council of the Royal Statistial Society, as we learn from the London *Times*, are sending out to various societies and councils a note on the Census Bill, drawn up by a sub-committee of the society, with a request that they will use their influence to induce Parliament to include in the Bill a provision for the taking of an intermediate census of a simple and comparatively inexpensive character in the year 1906, so as to afford to statisticians and others the benefits of a quinquennial numbering of the people. It is pointed out that, unless the Government can be induced to make provision for it at the present time, when the Bill for the decennial census is before Parliament, no opportunity will occur for another ten years. Regarding the Census Bill generally, the sub-committee in their note welcome the improvement in simplicity and arrangement of the provisions. They state that they made in all nine suggestions. Of these one has not yet been brought before Parliament another has been adopted in part only; six have found recognition; and one only has been ignored. The results are briefly as follows:—(1) Uniformity has been secured in two of the three kingdoms; (2) in Clause 1 the date recommended by the society has been adopted; (3) in Clause 4 (1) (*a*) the nationality of those born abroad is to be recorded; (4) in Clause 4 (3 and 4) the 'tenement' is substituted for the 'storey'; (5) in Clause 5 (1) the prescription that schedules are to be copied into books has been omitted, and in Clause 10 (1) (*c*) the matter is left to the registrars-general; (6) in Clause 5 (2) the record of houses occupied, though not inhabited by night, is ensured; and (7) the early introduction of the Bill this Session allows probably fair, though not abundant, time for preparations. The sub-committee, however, are greatly disappointed to note that the Bill contains no provision for an intermediate census of the simple character recommended not only by the Statistical Society, but by a very considerable weight of opinion in the medical, actuarial and municipal world. The Statistical Society has not recommended that the enumeration should be on each occasion in the full detail of a decennial census, which is the plan adopted abroad, but that the population by sex and age will suffice at the intermediate period. The project, though supported by the Departmental Committee of 1890, was rejected on the ground of expense, but this consideration carries less weight if it be held that the intermediate census is a necessary supplement to that of the decennial period, and that without it the latter

loses a great part of its value after a few years. The simpler enumeration would cost less than half as much as a general census, and, for £50,000 or so, would maintain the continuity of observation to an extent to which all those interested attach the highest value.

UNIVERSITY AND EDUCATIONAL NEWS.

By the will of the late Sidney A. Kent, of Chicago, the University of Chicago receives $50,000 and the Chicago Art Institute the same sum.

Mrs. Alice M. Rice, of Worcester, Mass., has bequeathed $25,000 to Bowdoin College and $5000 to the Worcester Polytechnic Institute. The latter institution also receives a further contingent bequest of $5000 and one-half the residue of the estate.

The Maryland Legislature has appropriated $24,000 a year for two years to the Johns Hopkins University. It will be remembered that for the past two years $50,000 has been given annually by the State to the University. The request for a continuation of the appropriation was bitterly opposed, but finally $25,000 was granted by the Senate. The House rejected the Senate Bill, as we reported last week, but it was finally brought up under the 'Omnibus' bill and passed, after being reduced to $24,000 a year.

On April 6th the Physical Laboratory of Lehigh University was destroyed by fire. The building was 220 feet long, 44 feet wide, and four stories high. It was built in 1892 at a cost of $115,000 and it contained apparatus worth about $35,000, most of which was destroyed. The private Library of Professor W. S. Franklin was mostly saved. The trustees at a meeting on the same day decided to rebuild at once the Laboratory, which will be equipped and ready for occupancy by next September.

The University of the South at Sewanee, Tenn., has received $50,000 from Mr. George W. Quintard of New York City.

Mr. Joseph A. Coran has given $20,000 to Bates College for a library building.

Mr. George B. Harrison, of Bloomington, Ill., has given to the Powell Museum, of Illinois Wesleyan University, a valuable collection of minerals, fossils, and specimens of natural history, which he has made during the past twenty-five years.

It is understood that part of the recent gift of $200,000 made by Sir William MacDonald, of McGill University, will be used to secure an extensive mineralogical collection.

An anonymous benefactor has undertaken to endow a Colonial Fellowship of £100 a year for five years in connection with the Liverpool School of Tropical Medicine. It will be granted to a graduate or student of a Colonial University who desires to carry on bacteriological work in the Thompson-Yates laboratories.

We much regret to learn that the board of regents of West Virginia University, Morgantown, W. Va., has formally received from President Raymond charges of insubordination and incompetency against five of the professors with the recommendation that they be dismissed. The members of the faculty will file countercharges and will insist upon the removal of the president.

Dr. Frank R. Lillie, professor of biology at Vassar College, has accepted a professorship in the zoological department of the University of Chicago.

Professor William Osler of the Johns Hopkins University states that he is not a candidate for the chair of medicine in the University of Edinburgh.

Dr. Edward A. Alderman, president of the University of North Carolina, has been elected president of Tulane University to succeed the late Col. William Preston Johnson.

Mr. H. Woods, of St. Johns College, Cambridge, has been appointed university lecturer in paleozoology.

Dr. Hermann Julius Kolbe, curator of the Zoological Museum of the University of Berlin, has been promoted to a professorship.

Dr. Hugo Hergesell, docent and director of the Meteorological Institute of the University at Strassburg, has been appointed associate professor.

Dr. Königsberger has qualified as docent in physics in the University of Freiberg, i. B. and Dr. August Klages, in chemistry at the University of Heidelberg.